# THE PREPARATION OF FLAX

BY THE

# CLAUSSEN PROCESSES.

# THE PREPARATION

OF

# LONG-LINE, FLAX-COTTON, AND FLAX-WOOL,

BY THE

# CLAUSSEN PROCESSES;

WITH

A DESCRIPTION OF THE CHEMICAL AND MECHANICAL MEANS EMPLOYED.



TO WHICH IS APPENDED,

## CLAUSSEN'S SYSTEM OF BLEACHING FIBRES, YARNS, AND FABRICS.

By JOHN RYAN, LL.D.

DOCTOR OF MEDICINE OF THE UNIVERSITY OF EDINBURGH;
MEMBER OF THE ROYAL COLLEGE OF SURGEONS, EDINBURGH;
FORMERLY, PROFESSOR OF CHEMISTRY TO THE ROYAL NAVAL COLLEGE, PORTSMOUTH DOCK YARD; AND TO THE ROYAL POLYTECHNIC INSTITUTION, LONDON;
LECTURER ON MATERIA MEDICA, AT THE CHARLOTTE STREET SCHOOL OF MEDICINE, BLOOMSBURY; ETC., ETC., ETC.

Illustrated by Engravings.

LONDON:
EFFINGHAM WILSON, PUBLISHER,
11, ROYAL EXCHANGE.

1852.

10. 9. 1873.

TO THE

# CHEVALIER CLAUSSEN,

MEMBER OF THE BRAZILIAN INSTITUTE;
OF THE GEOLOGICAL SOCIETY OF FRANCE; OF THE CUVIERIAN,
AND THE ETHNOLOGICAL SOCIETIES OF PARIS;
OF THE NATURAL HISTORY SOCIETY OF MAYENCE,
ETC., ETC., ETC.

THE FOLLOWING EXPOSITION OF AN IMPORTANT
DISCOVERY,
DESTINED TO BEAR HIS NAME,
IS DEDICATED,
AS AN ACKNOWLEDGMENT OF HIS FRIENDSHIP
FOR THE AUTHOR,
AND
AS A TESTIMONY OF HIGH RESPECT FOR
HIS SCIENTIFIC ATTAINMENTS.

# CONTENTS.



## PART I.

## PART II.



## PART III.

PAGE



## PART IV.



## PART V.

## APPENDIX.

# INTRODUCTION.

The Chevalier Claussen, some months ago, proposed to himself the task of writing a detailed exposition of his invention, for the use and guidance of workmen and others likely to be engaged in carrying it out. I regret, however, that the constant pressure of other engagements should have prevented the accomplishment of his design.

Such an exposition, has, at length, become imperatively necessary; and as I have had the honour to be associated with the Chevalier, from a very early period, in the practical development of his great discovery, I have been requested to undertake the duty, in his stead.

I am perfectly aware that the mechanical auxiliaries of the process, as described in this manual, are, at present, very incomplete. The elaboration of so vast a scheme must, of necessity, be progressive; and Claussen, regarding his process as one purely chemical, has left to others the application of the proper mechanical powers; feeling assured, that the discovery of a want, will, in the existing state of knowledge, be quickly followed by ingenious inventions, or successful applications.

An acquaintance with the processes of Alkalimetry, Chloriscopy, and Chlorimetry, is essentially necessary to a skilled workman; and, therefore, I have, in one portion of this work, given a few simple rules for his guidance.

Although anxious, throughout, to avoid all topics of a controversial character, yet I could not well pass over some of the objections, which are so continually urged against the propriety of converting flax into cotton; and, especially, such as are founded upon the assumed superiority of flax, in a monetary point of view. I have, also, thought it necessary to adduce high authoritative proofs that the chemical agents, employed by Claussen, are not injurious to the fibre.

My advocacy of Claussen's claims to originality, is based, not merely upon my belief in the independence of his discovery, but upon a sincere conviction, confirmed by repeated and anxious experiments, that none of the methods adopted antecedent to his own, were applicable to any fibre but that which had been already rendered "cottony," and half rotten, by over-retting: and that, even under such circumstances, the processes could never have attained a commercial scale of magnitude.

An extract is given from the Swedish transactions of 1747, and, also, a detailed account from Lady Moira's experiments, taken from her own letters. From these, it will be seen that "*pressing*," or "*beating*" the flax, was employed, in each case, to separate the fibres: on a very small scale, perhaps, "*beating*" may separate the filaments, although with injury to the staple; but its application, on a grand scale, would be an impossibility.

On the first announcement of Claussen's discovery, it was laughed at, as an absurdity; and certain obscure hints, of an intended microscopical *exposé*, prepared the public for the revelation of some system of imposture. When, however, the discovery became a *fact*, proved by actual and repeated experiments, in the presence of thousands, then it was scouted, by the same men, as a mad outrage upon commercial propriety—to be equalled only by "an attempt to convert gold into lead." From this post of offence, the opponents of the system were driven, by proving to them, that, in their ignorance, they had made a slight mistake—that, in fact, natural *cotton* represented the *gold*, and *flax* the *lead*; for flax, in its raw state, *costs absolutely less* than the despised cotton.

When the truth and economy of the process could no longer be doubted or ridiculed, then arose the outcry against its claims to novelty. It is also a strange phase in the history of beneficial inventions, that, judging from the eager delight, with which this fresh attack on Claussen was hailed by many, it might have been imagined, that instead of having laboured to introduce that which even his opponents are compelled to acknowledge to be a great national benefit, he had been detected in some most egregious attempt at scientific fraud.

In his Exhibition lecture, at the Society of Arts, Professor Solly was the first to allude publicly to Lady Moira's experiments, upon the conversion of refuse flax, into cotton, "by means, similar to those now adopted by Claussen."* Immediately afterwards, I sought most anxiously for an authentic account of those operations; and, at length, through the kind attention of Mr. Secretary Grove, I was permitted to peruse her Ladyship's MS. letter; but I sought in vain for any similarity in the processes. Where was the division of the fibre into lengths? Where that combination of acids and alkalies, on the necessity for which, Claussen so much insists? Where was the prototype of the beautiful and unique application of a gaseous force to the separation of the flax filaments? Where was the rapid bleaching so necessary to commercial success in the manufacture of such an article? In not one of these things—so prominently essential in Claussen's process, did Lady Moira's resemble his. I have, also, carefully sought in her Ladyship's letters, for Professor Solly's authority, for stating that Lady Moira had noticed "the increased affinity for colouring matter" attained by her cottonised flax. I find, there is, certainly, an allusion to some experiments upon "fixing lasting tinctures on linens," but nothing more. It is an error to suppose, that "cottonising," or the separation of the filaments, is necessary to the increased colour-absorbing power; indeed, a piece of linen cloth, after being subjected to the operations described in Part IV.,

* In the printed lecture, just issued, these expressions are omitted; but I allude to them, because they appeared in the passing reports of his lecture.

will receive lasting colours as readily as cottonised flax. Nor does this depend upon the boiling in caustic lye, and the after-souring; or otherwise, goods that have been bleached and soured by the ordinary processes, would be found to possess the same property.

---

Since writing the foregoing remarks, I have received the printed report of the "Commissioners appointed to enquire into the cost and applicability of the Exhibition building in Hyde Park." Henry Cole, Esq., a member of the Executive Committee of the Great Exhibition, was examined before the Commissioners, on the 30th of January, last. On that occasion, the noble Chairman proposed the following question:—"Has there been any want of knowledge, or of attention on the part of the enterprising portion of the public, in applying GUTTA PERCHA to every sort of purpose, since that time, do you think?" To which question Mr. Cole replied; "I am not able to say how much sooner the public would have got GUTTA PERCHA, by an institution of this kind, but they did get the first knowledge of it through the Society of Arts; but I can answer the question, on want of knowledge, by referring to another point, which is, the introduction of Claussen's flax cotton. Claussen is now almost fatiguing the public with this invention; and it seems that Lady Moira some 60 or 70 years ago went through precisely the same set of experiments, and she failed. The flax-cotton turned out to be worthless, and the spinners refused to use it; and so far as we can see, Claussen is going over precisely Lady Moira's ground at this time. Now, if you had any institution where any one who fancies he has got an invention, could apply and ascertain what has been done before, both the inventor's time and public patience would be saved, and general intelligence would be benefited." (Q. 566.)

For my own part, I cannot, for the life of me, perceive any connection between Lord Seymour's question, and Mr. Cole's answer; but, be that as it may, Claussen is made to suffer most unjustly. It has already been stated, that there is not the slightest similarity between Lady Moira's experiments, and those of Claussen; but as Mr. Cole's evidence must carry much weight with it, among the uninformed portion of the public, I have appended to this treatise a complete copy of Lady Moira's letters, as they appear in the *published* "Transactions of the Society of Arts." (*See Appendix* A.)

So unlike are the processes followed by Lady Moira, and by Claussen, that there can exist no reason why because her Ladyship failed, Claussen should fail also. What are the facts of the case? For six months, a factory has been in full work, in London; and the whole operations of the patent have been carried on, *not secretly, but in the presence of thousands, who have been allowed to inspect the process.* On some occasions, the works have been crowded by interested visitors, among whom are included some of the most distinguished members of the scientific and manufacturing world. It is notorious that Claussen has challenged close inspection; and, he is not surely to be blamed if he *has* "fatigued the public," by inviting his opponents to examine his process, candidly, and fairly, before they presumed to condemn him; nor does he deserve a sneer, because he has chosen rather to "fatigue the public," by a noble perseverance, and a large expenditure of his own means, than to allow a great and important invention, *either to be confounded with former imperfect attempts*, *or to be lost altogether*.

The patent of the Chevalier Claussen is now only about twelve months' old, the specification having been enrolled in February, 1851; and yet, for a period of time, extending over more than a year, *webs of flax cloth*, *spun and woven on cotton machinery*, *both alone*, *and in combination with natural cotton; webs of flax-wool-cloth of all colours; flax-wool-flannel*, *&c.*, *have been shewn*, *and given to the public*, *to be subjected to any test*, *microscopic*, *or otherwise*.

At this time, also, in Yorkshire, several highly respectable manufacturing firms are constantly using Claussen's flax cotton and wool; and, are "*fatiguing*" *him*, with applications for a larger supply.

During the short existence of the patent, not only has a working factory been in operation in London; but two companies, one with a capital of £250,000, and the other, with £200,000, have been formed, in Scotland, and in England, whose bills have already been read a second time in Parliament. In Holland, France, and Belgium, companies are established; and, in the latter country, *a factory is in full operation.* In the Northern States of America, ten companies have been formed to carry out the Claussen process; a display of confidence, and energy, arising from the fact of one of the most distinguished American chemists, and a highly intelligent merchant, from the United States, having spent a considerable time in Claussen's factory, in a searching examination of the economy and truthfulness of the invention.

Surely these are not symptoms of failure; nor indications that, so far as we can see, Claussen "is going over precisely Lady Moira's ground at this time."

Lady Moira certainly made flax-cotton; but as well might the important discoveries of Watt have been confounded with the experiments of Hero—the previsions of Worcester—or even the steam-engine of Savery—as that the rapid cheap and beautiful process of Claussen, should be identified with the tedious, weeks-consuming, and only partially applicable method of her ladyship: while, if the honesty of such attacks as those to which Claussen has been subjected, were once recognised, human ingenuity would be paralysed, and the force of intelligence would cease to be directed to the development, or application of ideas, lest some antecedent effort, however absurd and unsuccessful, should be discovered, and paraded as an opprobrium.

# POSTSCRIPTUM TO INTRODUCTION.

ANOTHER public attack upon flax cotton has just been made by Mr. Bazley, one of the Commissioners of the Great Exhibition, in a lecture delivered before the Society of Arts.

This, by the bye, is the fourth lecture, delivered before that Society, on the "RESULTS OF THE EXHIBITION," in which Claussen has been accused either of plagiarism or of failure; and from this, and other circumstances, the Chevalier believes himself to be, personally, the object of a *malus animus* on the part of certain individuals.

At the close of the Great Exhibition last year, two medals were awarded to Claussen—one for his circular loom, and the other for his flax cotton. Owing to circumstances which accompanied the awarding of the second medal, the Chevalier considered it his duty to refuse its acceptance. At the same time he made a public protest, in which he pointedly arraigned the justice and impartiality of the jurors. In order, also, to give greater weight to his protest, he published the copy of a letter, sent to him by one of the jurors—the Commissioner from the Spanish Government—in which letter, the Chevalier is distinctly given to understand that in the award of an inferior medal to him, *sinister* influences had prevailed against him.*

It is to be hoped, however, that much of this arose from misapprehension, for surely, moral *Thuggism* could have found no disciples among the workers in so great a cause.

Be that as it may, however, the Claussen process has certainly been the object of vituperation in four of the lectures on the "Results of the Exhibition," already delivered; as well as in the evidence of one of the Commissioners, when examined before parties appointed to enquire into the "cost and applicability of the Exhibition Building, Hyde Park."

Connected with this system of opposition, there is one circumstance, of a most expressive character, which it may be well to mention.

Among the thousands who have availed themselves of a working factory, where every opportunity of close and rigid investigation is afforded to visitors, not one of the gentlemen who have, *ex cathedrâ,* denounced the Claussen process, have taken the trouble to examine the matter for themselves. This is not just; nor can they plead indifference; for that which is considered worthy of their vituperation, is also worthy of their investigation.

Had Mr. Bazley examined this matter for himself, he would never have stated that flax-cotton could not be spun on cotton machinery; for he must, then, have seen *yarns spun from flax-cotton on cotton machinery*, *as well as fabrics woven*, *therefrom;* but, instead of seeking conviction by

* Appendix B.

practical, personal investigation, each opponent seems to take it for granted that the processes of Lady Moira, and of Claussen, are identical; and that, because her ladyship failed, he must fail also; thus, upon such false conclusions, public and official men, who ought to have shown themselves the patrons and supporters of ingenuity, have pronounced their *dicta*, and have promulgated errors.*

Why should not flax-cotton be adapted for cotton machinery? or in what does its inconformity consist? Take a sample in the hand, and with the fingers alone, threads of any length, and almost of any fineness, may be twisted, showing that the fibres have, undoubtedly, the power of attachment to each other, when so twisted; as they have, also, in the "milling" and "felting" processes. Why then, we repeat, should flax-cotton not be adapted for cotton machinery?

We are told that *she* who invented the arts of spinning and weaving, sprang from the parent brain of Jupiter, fully matured, and in complete armour—

"At sibi dat clypeum, dat acutæ cuspidis hastam,
Dat galeam capiti, defenditur ægide pectus."

Not so, however, is it generally with the offspring of the human brain; and in the earlier history of Claussen's invention, we find, among other tokens of immaturity, the presence of unequal fibres; and especially of such as were too long for the distance between the rollers of the spinning machine.

At that time, however, the means of cutting flax into

* Appendix C.

proper lengths were very rude and imperfect, exhibiting but little improvement upon the machinery used for chopping straw; but, let the reader now refer to the method of dividing the previously heckled and straightened fibre by the cutting apparatus described in this little manual, and he will, at once, perceive that the *opprobrium* need no longer exist.

Flax cotton, owing to the legal and commercial difficulties attendant upon the first movements of so gigantic an affair, of national—nay, of world-wide extent and importance, cannot yet be reckoned by its hundreds and thousands of tons; and, from the smallness of the quantity at present produced, it may be utterly beneath the notice of a Manchester manufacturer; still, the spinning and weaving of the first hundred-weight proclaimed the success of the fact, as completely as if it had already become the staple of the cotton mills of Lancashire.

I will take this opportunity of answering the oft-put question—"Why did Messrs. Bright and Sons give up the manufacture of flax-cotton?"

Messrs. Bright and Sons never were connected with Claussen's patent; never undertook the manufacture of flax-cotton; and are not, moreover, nor have been for some time, cotton manufacturers at all. The simple facts are the following:—Messrs. Bright, having an old mill, containing cotton machinery, standing idle, liberally placed it for a time at the disposal of the Chevalier Claussen, for the purpose of enabling him to try his earliest experiments. It was there he made his first essays; and there, upon Messrs. Bright's not very modern machinery, he spun his first flax-cotton. Imperfect as his first specimens were, they were shown in the Great Exhibition; and having so far succeeded, and feeling no inclination to be himself a manufacturer, he left Rochdale, and brought his invention before the public.

Subsequent circumstances, and especially those which prevented the carrying out of his process in Ireland, last summer, determined him to fit up, at his own expense, a factory in London, where, despite all prejudice and ridicule, he could prove the truthfulness and value of his invention.

JOHN RYAN.

*London, April 3rd,* 1852.

# THE PREPARATION OF FLAX

BY THE

# CLAUSSEN PROCESSES,

ETC.

## PART I.

Historical Notices of the Invention of Claussen.—Cottonised Fibre long regarded as a Desideratum.—A similar Process probably known to the Ancients.—Modern Attempts to adapt Flax to Cotton Machinery.—Extract from the Swedish Transactions of 1747, on the Subject of Flax Cotton.—Lady Moira's Letters published in the "Transactions of the Society of Arts."—Subsequent Attempts by Des Charmes and others.—None of these Processes fitted for unsteeped Flax —The Claussen Process proved to be original and unique.—Review of Objections urged against the Process of Cottonising Flax.—Natural Cotton is not cheaper than raw Flax.—The great Value of Long Flax depends on the enormous Labour required in its Preparation.—Average Prices of Flax and Cotton.—Dirty condition of some kinds of Cotton.—The Claussen Process includes the Preparation of Long Line.—Its Application to all fibrous Plants.

The possibility of converting Flax into a material resembling natural cotton, and open to the same course of manufacture, has long been a source of speculation; although, the contemplated results of such a discovery have varied considerably.

Cotton fabrics, at one time, were more scarce and expensive than linens; attempts were, therefore, made to give to the latter a cotton-like appearance, so that they might realise a higher price in the market. Eventually, however, such improvements took place in certain classes of machinery, that goods made from cotton, costing, in the raw state, more than flax, could be manufactured and sold at a much less sum than linen; and, consequently, it became a desideratum to adapt flax to the same treatment, so as to reduce the cost of the materials made therefrom.

Apart, also, from such mere mercantile views, patriotic speculators have, doubtless, attempted the accomplishment of such a desideratum, prompted by a desire to increase the internal resources of their own country; thus, seeking by the substitution of home-grown for foreign produce, to add to its wealth, and independence, as well as to the industrial force of its labouring population.

In the year 1850, the Chevalier Claussen, a gentleman highly distinguished for his scientific attainments, obtained a patent for "certain improvements in bleaching, in the preparation of materials for spinning, and felting, in yarns and felts, and in the machinery employed therein." The most remarkable feature of the patent was the method proposed for converting flax, hemp, and other similar fibres, into materials which could be spun upon existing cotton aud woollen machinery.

The narrative which Claussen gives of the circumstances, that gradually led him to the great results, now marking the successful issue of his labours, affords a striking instance of the way in which the operation of natural causes has frequently tended to discoveries, doomed to exert a vast influence on human progression.

While wandering, we are told, along the banks of one of the Brazilian rivers, near which his own estate was situated, his attention was arrested by the appearance of a white down-like substance, adhering to the branches which overhung and touched the water. On closer examination, although he was struck with its resemblance to cotton, he suspected it to be some hitherto unknown vegetable substance, and determined, if possible, to trace it to its source, for the purpose of ascertaining the tree or plant which had produced it. Following the course of the stream, he found that the indications terminated at a spot, where, at some former period, a heap of flax-straw had been deposited. To this, the swelling waters of the river had occasionally reached, producing fermentation, and the complete decay and separation of the wood from the fibrous portion of the plant. The flax, thus denuded and exposed, had, again and again, undergone the softening influence of the water, the expansive forces of the liberated gases, and the bleaching action of the air, until mechanical and chemical agencies had reduced it to a condition resembling that of cotton fibre.

The substance thus disintegrated by the alternate process of fermentative rotting, and atmospheric bleaching, had been rendered extremely weak, and almost unfit for use, as a textile material, yet, its appearance, produced by the agency of well-understood natural forces, first suggested to Claussen the possibility of so treating flax, by chemical influences, as to reduce it, quickly, and, economically, to a cotton-like state, without injury to its quality;—a desideratum, which had been sought by others, and, the advantages to be derived from which, had, years before, been predicated by Napoleon the Great.

It is due to the Chevalier Claussen to state, that when he commenced his investigation, he was not aware that the idea of adapting flax to cotton machinery had occurred to any one else; and, it was not until success had rewarded his labours, that he learnt how many attempts had been made to accomplish a like aim, and, that he alone, by the simplicity and rapidity of his process, had succeeded commercially.

From the appearance of Egyptian mummy cloth, it seems probable that the people of Ancient Egypt disintegrated their flax, in some way or other, preparatory to spinning. They spun, however, by hand, a very different thing from machine-spinning, presenting fewer difficulties, and requiring much less exactitude in the preparation of the material. The fact, however, is interesting, inasmuch as it proves that, ages ago, a question now frequently mooted by the opponents of the Claussen process, was fully answered, by demonstrating, that the cylindrical fibres of flax may be made to yield to the same operations of spinning, and may be converted into threads, closely resembling those manufactured from the flat and twisted fibres of natural cotton.

So much does the mummy cloth of Egypt resemble a cotton fabric, that, for a great length of time, its proper designation was a *vexed question* among our most acute scientific observers.

"Larcher, in his notes to the translation of Herodotus, and Forster, in his tract 'De Bysso Antiquorum,' had asserted, "from their own examination, that the mummy cloth of Egypt was cotton," as Rouelle had done before them, and as Rosselini has done since; even after most satisfactory evidence had been produced to prove that it was linen. Mr. Thomson, of Clitheroe, was the first to have recourse to the only satisfactory method, by which the fact can be determined, that is, by the use of the microscope. He had first ascertained that other methods of judging were unworthy of confidence, as several intelligent manufacturers, on examining a collection of pieces of mummy cloth, 'were of opinion, that the cloth was cotton, others that it was linen; and some, again, that there were in the collection specimens of both.'"*

It is evident, therefore, from the difference of opinion among "intelligent manufacturers," that linen may be made to undergo some change, which will give it, to the unaided vision, all the external physical characters of cotton; and, we may even speculate, how far the peculiar condition of the mummy cloth may have been produced by the action of the soda salt, held in solution in the natron lakes of Egypt. If the Egyptians did so treat their flax—the process, like many others of great importance, was eventually lost amid the confusion of succeeding ages.

The earliest notice of an attempt to cottonise flax, in modern times, is in the Swedish transactions for the year 1747; where a method is given of "preparing flax in such a manner as to make it resemble cotton in whiteness and softness, as well as in coherence. For this purpose, a little sea-water is to be put into an iron pot, or an untinned copper kettle, and a mixture of equal parts of birch-ashes and quicklime, strewed upon it. A small bundle of flax is to be opened and spread upon the surface, and covered with more of the mixture, and the stratification continued, until the vessel is sufficiently filled. The whole is then to be boiled with sea-water for ten hours; fresh quantities of water being occasionally supplied, in proportion to the evaporation, that the matter may never become dry. The boiled flax is to be immediately washed in the sea, by a

* *On the Culture and Commerce of Cotton in India and elsewhere.* By J. Forbes Royle, M.D., F.R.S.

little at a time, in a basket with a smooth stick, at first while hot; and when grown cold enough to be borne by the hands, it must be well rubbed, washed with soap, laid to bleach, and turned and watered every day. Repetitions of the washing with soap expedite the bleaching; after which the flax is to be *beat*, and again well washed. When dry, it is to be worked and carded, in the same manner as common cotton, and pressed between two boards for forty-eight hours. It is now fully prepared and fit for use. It loses in the process near one-half its weight, which is abundantly compensated by the improvement made in its quality."

In 1747, the finer cotton fabrics were more scarce, and much dearer than linen, and, therefore, more highly esteemed; and the object of the inventor of the tedious and expensive process just quoted, was, doubtless, to make linen assume, at whatever cost and amount of labour, the character of its more favoured rival, cotton.

In 1751, the aggregate imports of cotton into Great Britain, only amounted to 2,976,610 lb.; while in 1849, the imports reached the enormous number of 775,469,008 lb.; and even in 1782, when the imports had reached to 11,828,033 lb., the price ranged from 1s. 8d. to 3s. 6d. per lb.; but up to the year 1760, the machinery employed in the manufacture of that substance was nearly as simple as that of India; no wonder then that cotton should be dearer than linen. About that time, however, great improvements took place in machines used in cotton factories, and cotton and linen speedily changed their positions. "In 1738, Wyatt and Paul took out a patent for spinning by rollers; thirty years later, Arkwright perfected a similar machine; carding by cylinders was invented by

Paul in 1748; and from 1764 to 1767, Hargreaves completed the spinning-jenny. When these several machines were invented, yarns could be supplied in any quantity, and of improved quality, so that weavers could obtain as much as they required, and at a reasonable price, and manufacturers could use warps of cotton; for up to about the year 1773 linen yarn was used, as the warp, for nearly all cotton goods in this country."*

In the transactions of the Society of Arts for the year 1775, appear two most interesting letters from Lady Moira, detailing an account of her attempt to convert "*tow*" into a substance which would possess the characteristics of cotton; and in one of the letters, her ladyship distinctly alludes to the connexion which her labours had with the "*celebrated Swedish invention,*" to which reference has just been made. The expressions, however, just quoted, are only found in her ladyship's MS. in the museum of the Society of Arts, and not in the published transactions.

The following extract from one of the letters, will indicate the process adopted by Lady Moira. "The main purport in view," her ladyship writes, "seemed to me, the divesting the flax of its oil. I tried soap-boiler's lye with very good success, scouring it afterwards, to take off any bad effects of the lime used therein. I then had it tried to be scoured like wool, but found it required that the fermented urine, in that case, should not be mixed with water; and that kelp and common salt were necessary to be added to it. Either of these methods do. The boiling of it might, I am sure, be expedited by having a cover to

* *On the Culture and Commerce of Cotton in India, and elsewhere.* By J. Forbes Royle, M.D., F.R.S.

the iron pot, which might keep in the steam; and care must be taken as the liquor diminishes, to replenish it constantly. I have boiled some in a mixture of lime-water and salt: this had a harshness in it that more resembled the crispness of cotton; but the scouring of it would certainly deprive it of that quality; and leaving the lime in it, is confidently asserted here, would rot it. I own I doubt this effect; as I imagine that lime, after it is slaked by water, no longer retains its corrosive quality. In India and China, they use it in the washing of linen as regularly as we do soap.

"The '*tow*' is heckled and boiled in small faggots, tied up by thread, or a bit of tow. The 'backings' are carded in thin flakes, rolled up likewise, and tied. After boiling, they open in the same flakes they were carded into; and are washed out and laid to whiten in that form. I send you, however, a sample of the backings of white flax, that was only boiled four hours, and never laid down to whiten. In the course of this short process, you will see that the material of which sacking is made, is considerably mended, though I think it wants another hour's boiling, and that a week's whitening would have taken off that harshness of the flax it still, in some degree, possesses. It requires being *beat*, or put into a press, before it is carded on cotton cards, to separate the fibres, which seem to be set at liberty from each other, by a dissolution of some resinous substance of the flax, at the same time that the oil of that plant is converted into a kind of soap."*

In Lady Moira's day, technical chemistry was but little understood or courted; but her ladyship's experiments were quite in accordance with the most advanced scientific

* See Appendix A.

notions of the time, and were doubtless great improvements upon those of the Swedish inventor, in whose steps she professed to follow; yet, that her ladyship's process, thus detailed by herself, should be deemed to have even the slightest resemblance to that of Claussen, is a matter, certainly, for astonishment. Lady Moira's experiments were succeeded by many other attempts, in this country, and on the continent. In every case, however, the steps of the Swedish inventor were followed—only one variation occurring, where Des Charmes recommends the cutting of the tow into lengths.

Experience demonstrates, that neither flax nor tow can be cottonised, either by the tedious method adopted in Sweden, or by Lady Moira, unless it has first been subjected to fermentative decomposition, by dew or water retting; and has, afterwards, been beaten by the scutching machine, or some similar apparatus. Such was the condition of the flax and tow subjected to the operations just detailed; and we know that in dew, or water-retting, a portion of the flax is always more or less cottonised—that is, its thicker fibres are sub-divided into finer filaments. This is the case, also, where heaps of flax are allowed to ferment and rot, as in the instance which first drew Claussen's attention to the subject. The sub-division of fibres is always promoted by the scutching and heckling, to which the flax is subjected; and, if it happen to have been, originally, of very fine quality, a great part of the tow may be bleached, at once, into a cotton-like substance; but, unless the splitting or sub-division of the filamentous bundles, has taken place, previously—simple maceration, or even boiling, in soda, or soap, *will not accomplish that end.* Thus, while certain samples of steeped flax, or tow, may, by being boiled, bleached, and beaten, be fitted for spinning (at least, by hand), yet this is not true of those fibres, generally. The Claussen process, however, cottonises all descriptions alike, whether retted, or unretted, raw, or manufactured.

In anticipation of the more detailed account, which it is proposed to give of the Chevalier Claussen's Process of Cottonising, it may now be stated, that it differs most essentially from those already quoted, as well as from others, inasmuch as—

First. He deems it as necessary to boil, or macerate the fibre, in dilute acid, for the purpose of removing foreign matters, as it is to steep it in caustic alkali; he, therefore, employs both these agents.

Secondly. By forming a compound, or salt, within the filaments themselves, he proposes to alter the electrical condition of the fibres, and to fit them for *the reception of colouring matters, and for the operations of felting*, *and milling.*

Thirdly. By the agency of an invisible and elastic gas, he breaks up the fibres into their finer, and even ultimate filaments; thus obtaining, from the subtility of carbonic acid, that aid which no mechanism could afford, nor maceration supply.

Fourthly. He bleaches the cottonised fibre by a new method, and by means of new agents.

Although the materials used by Claussen, in the first and second of the above processes, have long been employed in laboratory practice, for the production of *pure fibre*, or *lignine*, yet the *modus operandi* is new; and some of the objects, which are sought to be accomplished, by their action, are peculiar to himself.

The third and fourth steps in the process are new and peculiar; and one of them is, without doubt, absolutely essential to the production of flax, cotton, or wool, on a commercial scale.

---

One of the most common objections to the conversion of flax into factitious cotton, is, that the former material, being so much more valuable than the latter, would, by the process of cottonising, be subjected to a change, as absurd as that which would mark the transmutation of gold into ignoble brass.

Such an objection, however, arises either from an erroneous view of the Claussen process, and an ignorance of the existing modes of manufacturing flax; or, from the mistake of accepting extraordinary prices, occasionally obtained for a very extraordinary article, instead of the average price of an ordinary product.

It is not correct to say, that flax is, in a monetary sense, more valuable than cotton. It is true that the very finest descriptions realize a high price; but, we must not forget that the best Sea Island cotton is always quoted considerably higher than any flax, being, from two shillings, to five, and even seven shillings, per lb.

To select, however, the highest prices, either of flax or of cotton, is not a proper mode of arriving at an estimate of the comparative value of the two substances; we must examine the prices paid for the great bulk of the materials consumed.

The average price of flax, according to the reports of the Royal Flax Society, is £50 *per ton,* or about 5½*d. per lb.*; a sum about equal to the average of *"Surats,"* the lowest quality of cotton, and considerably below the average of the whole of the cotton imported into this country.

Besides, while flax is sold to the linen manufacturer *clean*, and freed from all foreign matters, cottons, especially the lower qualities, are full of dirt, the removal of which, with the consequent loss of weight, amounting to at least *one-fourth,* adds very materially to the price of the imported article.

Thus, we learn that while the raw material for the linen manufacturer is actually cheaper than that consumed by the cotton spinner, the price of the linen fabric is more than quadruple that of cotton goods. Let the flax, however, be prepared for spinning and manufacturing on cotton, instead of linen machinery, and we shall soon have a solution of the mystery, and a triumphant illustration of the value of the Claussen process. "The spinning of one pound of cotton costs only 3*d.*; while, the average expenses of the flax processes, on yarn of similar quality, and by the ordinary flax machines, reach as high as 10*d.*" *

Those who object to the process of cottonising, must, also, recollect that, although, £50 per ton is quoted by the Royal Flax Society, as the average price of flax, yet, in obtaining the one ton, *great expense and labour* are incurred; a large quantity of fibre, also, is either wasted, or converted into comparatively valueless tow. All the flax fibre is not saleable at £50 per ton; but the following may be considered as a fair statement of the yield of flax straw, under existing systems of treatment.

One ton of straw produces two and a half cwt. of *flax*, properly so called, and one cwt. of *tow*. There is also a

* *Curiosities of Industry*, part v.

considerable quantity of waste in the form of fibre, adhering to the "*shoves*," or wood, removed during the operation of scutching. This, amounting, in some cases, to 35 per cent. of their weight, is too short even for tow.

Seven pounds per ton is about the average price for unmanufactured or unheckled tow. If, therefore, one ton of straw yields two and a half cwt. of flax, worth at the rate of £50 per ton, or fifty shillings per cwt, and one cwt. of tow, worth £7 per ton, or seven shillings per cwt., the gross value of the whole would only be 132 shillings; while, if the three and a half cwt. of flax and tow were cottonised, and sold at the present price given for flax cotton, or flax wool, the sum realised would be 196 shillings, without taking into consideration the weight of the shove-fibre, which might be saved, and added to the total.

To manufacture three and a half cwt. of flax cotton, or flax wool, from the straw, would also, as will, hereafter, be shewn, entail very much less expense and labour than the production of the two and a half cwt. of long line, and the one cwt. of tow.

Flax wool will always command a high price in the market, because, from its *felting* and *milling properties*, it can be used with animal wool, and thus displace an expensive article; but, in the manufacture of flax cotton, we must consider the price of the natural cotton. The following list shews the average of all descriptions, during a period of ten years.

| Years. | Price of other than East Indian Cotton at Liverpool. | Price of Surat Cotton at Liverpool. |
|---|---|---|
| | Pence per lb. | Pence per lb. |
| 1839 | $5\frac{3}{4}$ to $7\frac{3}{4}$ | $4\frac{3}{4}$ to $6\frac{1}{4}$ |
| 1840 | $5\frac{1}{4}$ to 7 | 4 to 5 |
| 1841 | $4\frac{5}{8}$ to $6\frac{3}{4}$ | 3 to 5 |
| 1842 | 4 to 6 | $3\frac{1}{4}$ to $4\frac{1}{2}$ |
| 1843 | $4\frac{3}{8}$ to 6 | $3\frac{1}{8}$ to $4\frac{1}{8}$ |
| 1844 | $3\frac{3}{4}$ to $4\frac{5}{8}$ | 4 to $4\frac{1}{4}$ |
| 1845 | $3\frac{1}{2}$ to $4\frac{1}{2}$ | $2\frac{1}{2}$ to $3\frac{3}{8}$ |
| 1846 | $4\frac{1}{8}$ to 7 | $3\frac{1}{2}$ to 5 |
| 1847 | 6 to $4\frac{1}{8}$ | 5 to $2\frac{3}{4}$ |
| 1848 | $3\frac{1}{2}$ to $5\frac{1}{2}$ | $2\frac{5}{8}$ to $3\frac{3}{4}$ |
| 1849 | $5\frac{5}{8}$ to 8 | $3\frac{3}{4}$ to 5 |

In the year 1850, the average of all descriptions of cotton was twopence per lb. over the prices of the year preceding it.

Although, at first sight, the "Surats," or inferior cottons seem to realise a sum so small, that it would be almost impossible for artificial cotton to compete with it; yet, it is necessary to bear in mind how much that price is enhanced by the loss of weight, in removing its large amount of adulteration, as well as by the necessary labour bestowed in the process. Mr. Aspinall Turner, President of the Commercial Association of Manchester, in his examination before a Parliamentary Committee, states, "that in the spinning establishment of which I am the head, we are in the habit of throwing upon the waste land, an amount of dirt, for which we have paid £7,000 per annum, chiefly consisting of soil, sand, dirt, and various extraneous matters, which have been introduced, I suppose, or have never been cleaned out of the cotton." (Q. 789).

Other highly intelligent manufacturers state, that the loss of weight in inferior cottons, from the cause to which reference has just been made, is, at least, one-fourth.

Taking all these things into consideration, and, even supposing that flax cotton, which is much stronger than the natural product, should only be able to compete with "*Surats*," the transformation of flax, from the straw, into an article to be spun on cotton machinery, is not so absurd as many have supposed.

If Claussen proposed to convert long line, worth, on an average, £50 per ton, into cotton, the absurdity would be evident: but, he either confines himself to the use of refuse tow, or begins with the straw itself; and, as in his process, he obviates the necessity of *scutching*, one of the great items of expense in making long line, is avoided.

Under existing systems, eight tons of straw are consumed in the production of only one ton of long line, and eight cwt. of tow: therefore, as good straw contains, on the average, one-fourth of its weight of fibre, there must be great waste in some part of the process. This arises, no doubt, in a great measure, from the quantity of useless short fibre which is caused by the operation of scutching. In the Claussen process, however, no scutching is required, and no "shove" waste is produced; while a ton of fibrous material is obtained from four or five, instead of eight, tons of straw.

Taking, also, another view of the subject, and granting that the price quoted, by the Royal Flax Society, is much below the average (which, however, is not the case), yet, such a circumstance would not militate against Claussen, inasmuch as, under his patent, long line equal to, if not superior to, any in the market, is produced; therefore, while he is enabled to compete with other manufacturers, in supplying the makers of linens with flax, the short fibre which would, otherwise, become tow, can be converted into cotton and wool.

Did no other beneficial result accrue from Claussen's invention, yet, the conversion of the refuse tow of the flax manufacturers, into a beautiful, white, cotton-like substance, suited for paper-makers, would, alone, be sufficient to stamp it with vast importance.

In this country, the consumption of rags, for paper-making, amounts to upwards of 120,000 tons, per annum, averaging from £26 to £30 per ton. The rags, thus largely purchased, are principally cottons and coarse linens, both dyed and printed, therefore entailing upon the manufacturer the trouble and expense of scouring, bleaching, and tearing; while, so much more valuable are white linen rags considered, that from 10*d.* to 16*d.* per lb. are frequently paid for them. Cottonised tow is quite equal to linen rags, and being perfectly bleached, divided and clean, is, at once, ready for the pulp machine.

Portions of other plants, besides hemp and flax, may be with great advantage, subjected to the Claussen process; and even such as contain no true fibre, as the straws of some of our cereals, may be fitted for the paper mill, or for other technical purposes. Anticipating the extended application of his valuable processes to almost every description of fibrous plant, the inventor states, in his specification: "By the term *fibre,* I mean the portion of each plant which is capable of being spun or felted; and my invention applies especially to the fibre surrounding stems of dicotyledenous, and to that existing in the stems and leaves of monocotyledenous plants."

## PART II.

Flax-straw.—Various Processes of Retting.—Eremacausis injurious to Fibre.—Breaking the Straw.—The Shove Boon or Wood may be used with Cattle-food.—Claussen's object in breaking the Straw is peculiar to himself.—Mr. Lee's Patent.—Flax should always be steeped after breaking.—Breaking Machines.—Claussen's Process of steeping Long Fibre.—Description of Vats.—Cold and hot Steeping.—Method of combining the Chemical Agents.—Table of the Quantities of Acid, or Soda, and Water, required.—Instructions for making Caustic Soda.—Precautions to be adopted in the Process.—Alkalimetry.—Preparation of Test Acid.—Dr. Normandy's Alkalimeter.—Caustic Soda and Sulphuric Acid of the Strength employed do not injure Fibre.—Dr. Ure's Evidence on the Subject.

The Claussen Processes consist of three parts :—

*First.* The preparation of long-flax, for the linen manufacturer.

*Secondly.* The conversion of flax, or hemp, or the refuse of those fibres, into a material resembling cotton or wool.

*Thirdly.* The bleaching of fibres and of fabrics.

Flax-straw, the seed having been removed, consists, mainly, of two portions, the woody heart or "*boon*," and the "*harl*," which, with its fine cuticle, encloses the boon, like a tube. The *harl* furnishes the flax fibres; and these, in their natural condition, are attached firmly, not only to the *boon,* but, also, to each other, by a substance of great adhesive power.

The first object of the flax manufacturer is to destroy this union; and nearly all the methods of accomplishing this, involve the process of fermentation, whose action and results are well described, by the popular term *"retting,"* or rotting.

Retting is established by immersing the flax-straw, for a time, in still, or running water, until the crisis of fermentation has arrived ("*water-retting*"); by exposing it to the influence of the air and moisture ("*dew-retting*"); by a combination of both methods ("*mixed-retting*"); or, by subjecting the straw to the influence of water, artificially heated, so as to hasten the process (Schenck's patent).

The three first methods are no doubt of great antiquity; but the employment of warm water, instead of that of the ordinary atmospheric temperature, seems to have been first proposed in the year 1787.

Another very neat and convenient way of retting is adopted by Sir John Macneil and others, in which they avoid the variations of temperature, which accompany steeping in the open air. For this purpose, the vats are placed inside a building, and being filled with the material to be retted, and supplied with cold water, are covered over with glass tops. The employment of glass covers serves to admit the light, which is so necessary to rapid fermentation, while, at the same time, the interruption to the decaying process, by changes in the atmospheric temperature, is effectually prevented.

During fermentation, the nitrogenous portions of the plant, such as the *gluten, albumen,* etc., suffer an early change, in obedience to the law, which renders those bodies, constituted of the greatest number of elements, the most liable to decomposition. *Eremacausis,* however, soon spreads, and the boon, or wood, is next affected. The carbon of this portion of the plant combines rapidly with atmospheric oxygen, to form carbonic acid; a diminution of weight ensues, and, eventually, the woody part of the flax becomes so friable (*rotten*), when dry, as to be easily removed by *rubbing,* or *beating.* This is, in fact, the condition sought by the steeper; but, although fermentative combustion may attack the fibre last, and least of all, because of its compactness, and the smallness of the surfaces exposed, yet it does most certainly injure it; and, in time, would, without great care, entirely *rot it.* Fermentation, therefore, when established in the flax plant, is a capricious, and dangerous operation.

---

One of the most prominent features in the Claussen process of preparing long flax, is the employment of a machine for "*breaking*" the straw while in its raw state, and removing a great portion of its woody matter. If the straw be artificially dried, 50 per cent. of wood can be removed by such means; and, under ordinary circumstances, without drying, from 20 to 30 per cent. can be separated from the fibre. To the flax-grower, such an apparatus is of immense importance, as it enables him to reduce, very materially, the bulk and weight of his produce, thus facilitating its transit to market.

The restoration, also, to the soil, either directly or indirectly, of so large a proportion of the crop, is of great advantage. Sir Robert Kane observes, "the agriculturist should steadily bear in mind that the fibre, which he sells to the flax spinner, has taken nothing from the soil. All that the crop took out of the soil, he has still in the steep water, and in *the chaff of the scutched flax* (the boon, or woody part); and if, after suitable decomposition, these be returned to the land, the fertility of the latter will be restored; and, thus, materials at present utterly neglected, and even a source of inconvenience, may be converted into valuable manures." *

The eminent chemist, just quoted, speaks in the foregoing paragraph merely of the chaff of *retted flax*, and, therefore, does not recommend its employment as food for cattle. The reason for his not doing so, is obvious; because, by the process of fermentative rotting, all the nitrogenous, and soluble portions, useful for food, are removed. The chaff, however, of raw flax, contains a large amount of nutritive matter, including a considerable proportion of azote, the basis of the most valued food. We are told that "the forms of ligneous fibre, which constitute the commercial flax and hemp, do not contain nitrogen; and yet those plants which are cultivated for their production, *are rich in nitrogen.*" †

The mere "breaking" of the raw, or unsteeped flax straw, for the purpose of removing as much as possible of its wood, is not peculiar to the Claussen process. It was the subject of a patent granted to Mr. Lee in the year 1812; and has been proposed lately as the basis of another patent: *but, Claussen's object in "breaking" is peculiar to himself.*

Mr. Lee, as well as some of his more recent imitators,

* *Industrial Resources of Ireland.* By Sir Robert Kane, M.D.

† *Elements of Chemistry.* By Sir Robert Kane, M.D.

proposed by "breaking" *to do away with the necessity for subsequent steeping; Claussen, on the contrary, "breaks" his flax, as a preparatory step to successful steeping;* because, he is aware, that *unsteeped* is found to be, practically, not so good as steeped flax. Dr. Ure, in referring to this subject, says, "Mr. Lee's improvement (the breaking without steeping), has apparently come to nought, having been many years abandoned by the patentee himself; though he was favoured with a special Act of Parliament, which permitted the specification of his patent to remain sealed up for seven years, contrary to the general practice in such cases." *

The failure of Mr. Lee's plan did not depend upon any difficulty attendant upon its execution; nor did it arise from any injurious action on the fibre—its want of success evidently arose from the absence of some proper mode of cleansing the fibre afterwards. A writer in the *Encyclopædia Britannica,* states: "We have seen Mr. Lee's process performed by workmen under his own direction, at Old Bow, near London, with the most complete success; not merely upon handfuls of flax, but upon whole fields of it. Indeed, the whole is so extremely simple, that we cannot well see how it should fail, if properly conducted." † Steeping the broken flax, for a few minutes, in hot water, was part of Mr. Lee's process, but was proved to be inadequate to the production of a useful fibre.

---

There exist two classes of opponents to Claussen's pro-

* *Dictionary of Arts, Manufactures, and Mines,* Art. Bleaching.

† *Supplement to the Encyclopædia Britannica,* Jan. 1st, 1817.

position for breaking flax straw, in its raw state, and preparatory to steeping.

*First:* Those who insist that no machine can be applied to unsteeped flax, without injury to the fibre.

*Secondly*: Those, who still, despite Mr. Lee's failure, and the evidence of men of great experience, propose to prepare flax for the manufacturer, by mechanical means alone, *and without steeping.*

The first class of opponents should remember, that, although, in 1812, when Mr. Lee obtained his patent, the description of machinery employed may well be supposed to have been inferior to that, which more extended knowledge and experience produce in the present day, yet, it is notorious that his plan *did not owe its failure to any injury committed upon the fibre:* practical experience is therefore against them.

To the second class of opponents it may be answered, that, although, it has been desirable to avoid the dangerous and unpleasant operation of steeping under the old systems, yet experience has shewn, that mere mechanical appliances will not sufficiently clean the flax. On this point, the following is the evidence of one of the most distinguished practical chemists of the day. "The waste of time and labour in the steeping of flax; the dyeing of the fibres consequent thereon, which must be undone by bleaching; *the danger of injuring the staple by the action of putrescent water; and, lastly, the diminished value of flax, which is much water-retted*—are all circumstances which have, of late years, suggested the propriety of superseding that process, entirely, by mechanical operations. It was long hoped, that by the employment of breaking-machines, the flax, merely dried, could be freed from its woody particles; while the textile filaments might be sufficiently separated by a subsequent heckling. Experience has, however, proved the contrary. The machines, which consisted for the most part of fluted rollers, of iron or wood, though expensive, might have been expected to separate the ligneous matter from the fibre; but in the further working of the flax, no advantage was gained over the water-retting process."

The same eminent authority proceeds to state, that "the parting of the fibres in the unretted stalks, is imperfectly effected by the heckling; the flax either remains coarser, as compared with the retted article, and affords a coarser thread; or if it be made to receive greater attenuation, by a long-continued heckling, it yields incomparably more torn filaments and tow.

The yarn of unretted flax feels harder, less glossy, and rougher; and, on account of these qualities, turns out worse in the weaving than the retted flax." *

Injury to the fibre is not enumerated by Dr. Ure among the disadvantages of "breaking," in the raw state. This is favourable to the Claussen process, whose after-treatment of the fibre effects, completely, the removal of that harshness and adhesiveness, which, until lately, it was supposed, could only be accomplished by fermentation.

The objections urged by Dr. Ure and others, may, perhaps, be supposed not to apply to those manufactures in which only coarse threads are employed, and where softness and smoothness are not required; but, unless fabrics thus manufactured are afterwards subjected to a

* Dr. Ure—*Dictionary of Arts, Manufactures, and Mines.*

process of scouring and bleaching, the least exposure to moisture will set up a tendency to *eremacausis,* and rottenness will speedily ensue; because, mere mechanical operations cannot remove the whole of the azotic or nitrogenous matters existing in contact with the fibre, and which enter so very readily into a state of fermentative decomposition.

---

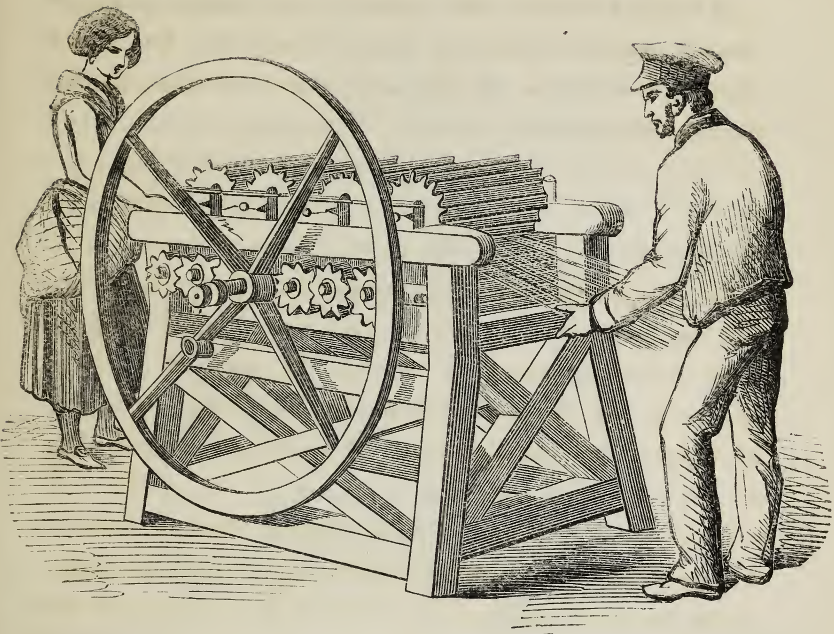
Flax manufacturers are in the habit of using "*breakers,*" for the purpose of crushing the straw, *after* steeping. Such machines, however, are not fitted for the objects sought in the Claussen process; as, in all cases, the flax operated on, by them, requires to be scutched afterwards, for the removal of the wood.

If straw, in its raw state, be passed through what is termed a "breaker," the cylindrical form of the harl-tube would be destroyed, and the boon would be flattened and partially broken; but, scarcely an atom of the wood would be actually removed. Such a machine, therefore, would not serve the farmer, by enabling him to return to the land any portion of his crop, nor would it diminish the weight of the produce to be transported.

Breakers, at present, consist of a number of fluted rollers, between which the flax straw is passed, after steeping.

Fig. 1. represents a *breaking machine,* designed by Mr. Warnes, a gentleman who has devoted his energies to the flax cause. It is, however, only adapted for *steeped flax;* the raw straw would scarcely lose a particle of wood, in passing through it.

FIG. I.



A number of other flax-straw breakers are in use in different localities; some consisting of straight, and others of conical rollers; but none of them are fitted for removing the wood of unsteeped flax.

It is evident, that to remove the wood of raw straw, something more than mere crushing by fluted rollers is required; and, therefore, Chevalier Claussen, at an early period of his invention, seems to have directed his attention to this point. In the great Exhibition of 1851, he exhibited a model of a flax straw-breaker, of which the following is a description:—

Fig. II. is a perspective view of the machine.

Fig. III. a section of the same.

The same letters apply to both engravings.

The operation of the machine is as follows:—the flax enters between the two fluted feed-rollers *a a*, and is conveyed forward, by them, to the four-sided toothed roller, or revolving brake *b*. The upper brake *c*, which is fixed to the slide *d*, and works in the framing *e e*, is brought down by the crank *f*, and connecting rods *g g*. During the ascent of the upper brake *c*, the catch, or

Figure II.

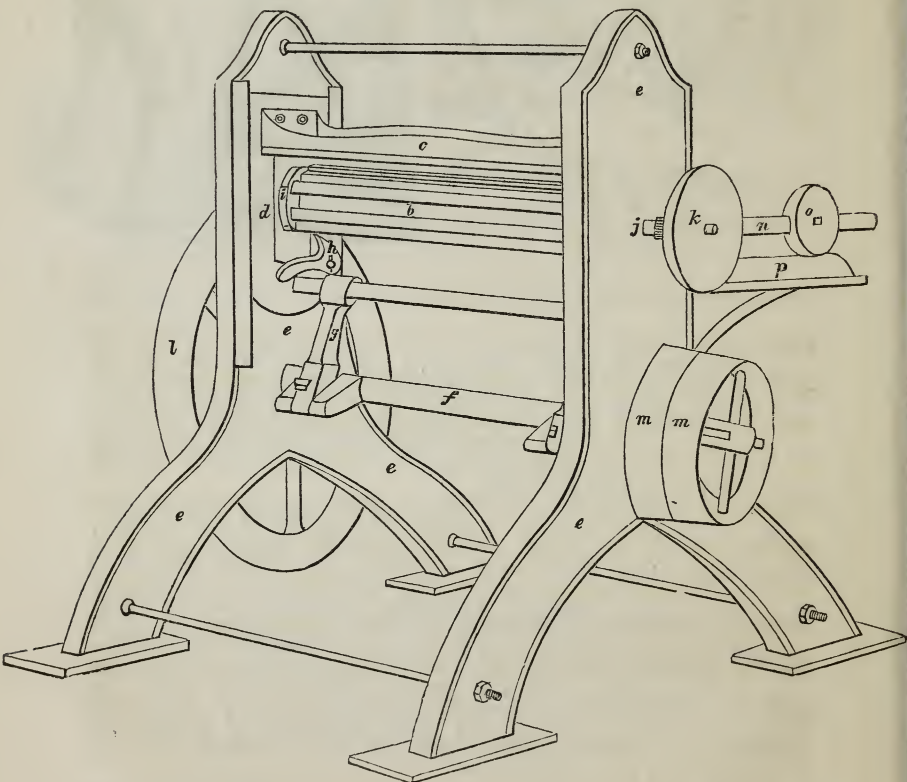
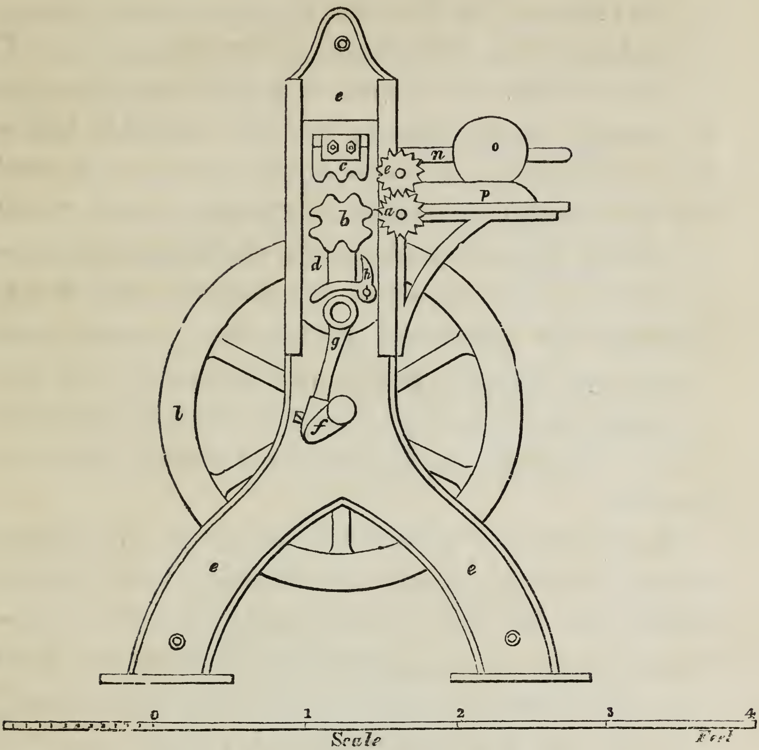


FIGURE III.




pall *h*, acts upon a ratchet-wheel of four teeth *i*, on the end of the revolving brake *b*, which, by a small-toothed pinion *j* working in an inside spur-wheel *k*, gives motion to the fluted feed roller, *a a*. On the other end of the revolving brake *b*; is a square of iron, not shown in the engraving, which, being pressed upon by a lever, actuated with a spring, keeps the revolving brake *b* in a proper position during the descent of the upper brake *c*: *l* is the fly-wheel for equalising the motion; *m m* the driving pulleys; *n n* levers; *o o* weights for weighting the feed-rollers *a a*; *p* the feeding board, on which the flax-straw is spread evenly, preparatory to entering the feed-rollers.

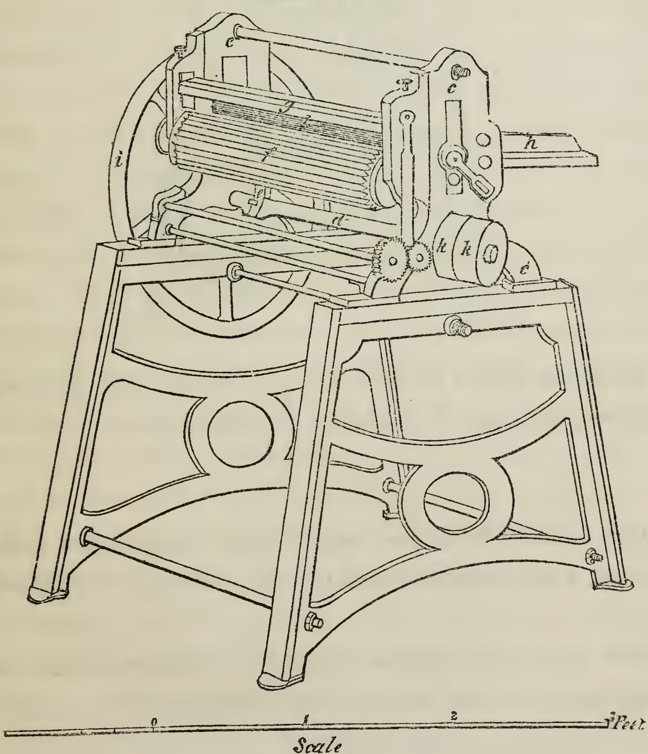
The object of the Chevalier Claussen, in the construction of this machine, was to obtain the three distinct actions of *crushing*, *beating* and *rubbing ;* so that, without injury to the fibre, as large an amount as possible of wood might be removed, *before steeping*; but, the apparatus having been manufactured at a considerable distance, and without the personal supervision of Claussen, it was found, in practice, to be too ponderous for the farmer, as well as imperfect in its construction and material. Mr. Moore, therefore, has constructed for Claussen, a much more perfect and portable machine (see Figures IV. and V.), by means of which, dried unsteeped straw is denuded of 50 *per cent.* of its wood, without the slightest injury to the fibre.

The operations of this machine commence with placing the flax on the feed board *h*, and offering it to the drawing rollers *a a*. The flax, having passed an inch, or two, through these rollers, is seized by the oscillating fluted rollers *b b*, which are moved up and down in the framing *c*, by the crank *d*, and connecting rods *e e ;* the superiority of this motion being, that the wood, or boon, is as completely broken, as though rubbed out by the hand; while, at the same time, the fibre remains perfectly uninjured, through its entire length, whatever that may be. The bott-hammer, so universally employed in Belgium, has, also, by a mechanical contrivance, been adapted to the machine. The parts consist of a toothed wooden roller *f*, over which the broken flax is delivered, after leaving the oscillating rollers *b b*. The flax is struck, while on the roller *f*, by a toothed wooden hammer *g*, which not only divests the flax of any remaining boon, but materially preserves the parallelism of the fibres.

In Fig. II. and III., the brake is brought down by the steadily increasing, but unyielding pressure of a heavy crank; consequently, any deviation in feeding, however slight, produces mischief.

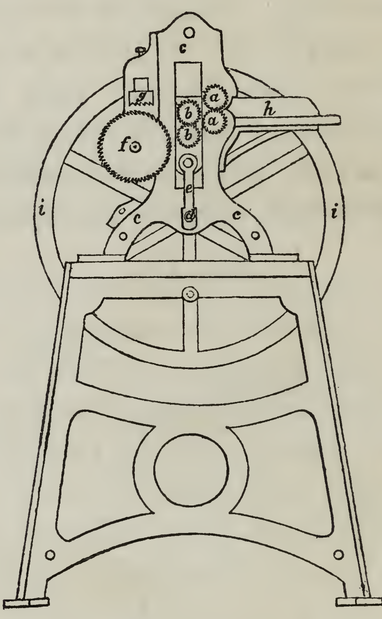
The mechanical bott-hammer, however, in figs. IV. and V., being raised by two small quoins, is allowed to drop on the flax, by its own weight alone, such weight being immediately raised again; therefore, be the quantity ever so small, even to a single layer, the straw is as equally struck or broken as any larger amount; while, an increased quantity, no matter how thickly spread, is, by such mechanical adaptation of the bott-hammer, completely prevented from being cut through, or in any way injured.

Fig. IV.



Another advantage, peculiar to the oscillating roller machine, is, that none of the rollers are weighted; the top of one tooth is also prevented from touching the bottom of any other; *h* is the feed board, *i* is the fly-wheel, *k k* the driving riggers, or pulleys.

Fig. V.




As this machine is especially constructed for farmers, a hand motion may be affixed to it, if required.

---

The broken flax-straw must now undergo the action, first, of weak caustic alkali; and, secondly, of acidulated water.

This operation may be carried on either at the usual temperature of the air, at the boiling point, or at any of the intermediate degrees of heat.

The flax is tied up, loosely, in bundles, or sheaves, of about two pounds weight each; and is transferred to a vat or tank, capable of holding one ton.

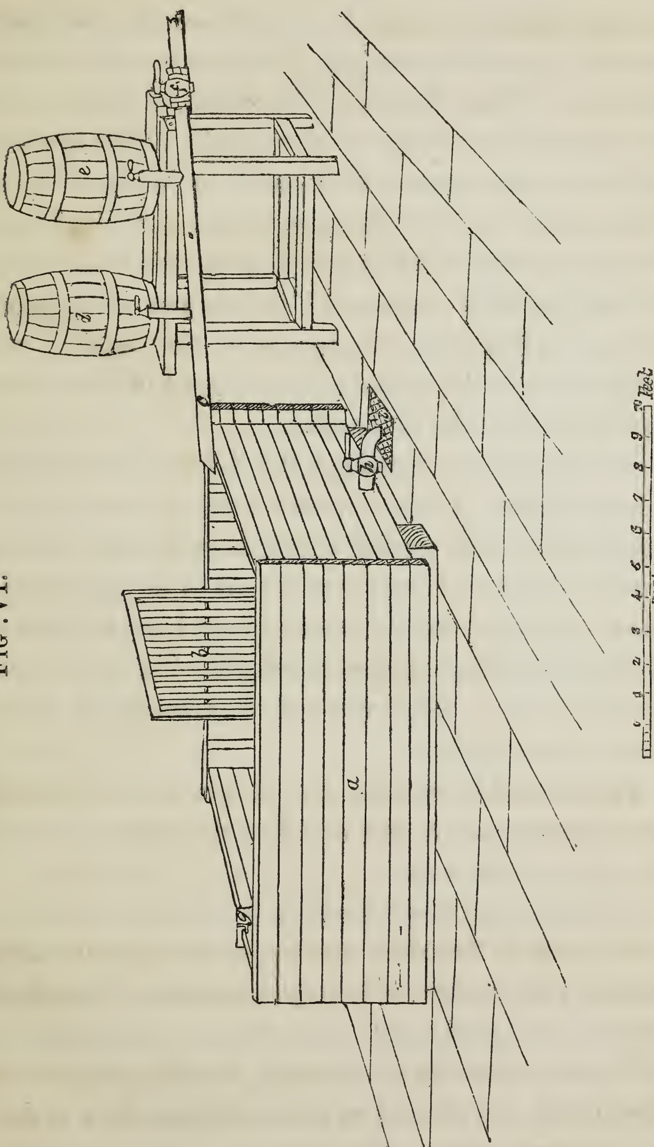



Fig. VI.

*a*, Fig. VI. is a wooden vat, in which there is a false bottom, raised about six inches, and perforated with holes, or made open like common lattice work. In order that the bundles or sheaves of flax may not become entangled or matted together, during the boiling or steeping, frames or lattice divisions may be placed between each pile of sheaves; one of these frames, *b*, is represented half out of the tank. These divisions slide either in grooves, cut in the sides of the vessel, at about eight inches apart (like shelves in an ordinary book-case), or between fillets of wood, nailed or screwed to the inside. In packing the flax, preparatory to boiling or steeping, the frames may be all fixed in their places, and the sheaves piled between them; or, beginning at one end of the tank, a row of bundles may be built, and a frame slipped in front of them, and so on, until the vat is filled.

For the purpose of boiling the liquor in the vat, there is a steam-pipe, *g*, which passes down one corner of the vessel, and is then carried round it, underneath the false bottom, where numerous perforations in the pipe allow the steam to escape, and to communicate heat to the water. When the boiling process is adopted, the tank must be provided with a cover of wood, to prevent the waste of heat, by evaporation.

The vat may be emptied after each operation, by opening the discharge cock *h*, and allowing the liquor to run into the sewer, at the trap *i*.

If the process of *cold* steeping is adopted, a solution of caustic soda 2° Twaddell, specific gravity, 1·010, remains in contact with the flax for twenty-four hours. The alkaline liquor is then discharged, and sulphuric or muriatic acid, and water, indicating 2° Twaddell, specific gravity, 1·010, is admitted, and allowed to act on the flax, for a period of two or three hours. The discharge cock is then opened, and after washing the contents of the vat with a plentiful supply of clean water, until no acid reaction is visible on test paper, the flax is removed, and dried in the usual way.

If the *boiling* process is adopted, the strength of the alkaline solution need not exceed 1° Twaddell, specific gravity, 1·005. The boiling is continued four hours, and then the liquor is discharged as before; and after draining the flax, water, acidulated with sulphuric or muriatic acid up to 1° Twaddell, specific gravity 1·005, is to be admitted. The temperature is again to be raised to the boiling point, and after half an hour's ebullition, the acid is discharged, and the flax well washed with clean water. The liquor should be frequently examined in the last stage of the process; for, if the soda, remaining in the fibre, is strong enough to neutralise all the acid, more must be added, so as to give a decided acid reaction to litmus paper.

Steeping in cold acid of 2° Twaddell, specific gravity, 1·010, for two or three hours, is preferable to the boiling, just described.

It is important, that the flax should not be packed too closely in the vat, or the acid and alkaline solutions will not have sufficient influence on the fibre.

The flax, after washing, should be subjected to a bath of soap water; and when dry, it must once more be passed through the *breaker* described in Figs. IV. and V.

If *unbroken* flax be subjected to the steeping process, a less amount of acid is required, but a longer time must be allowed for its action.

If boiling be inconvenient, any increase of temperature above 90° of *Fahr.*, will advance the process of steeping, very much. If the temperature of the vat does not exceed 150°, the quantities of alkali, and of acid, may be such as are employed in cold steeping; but, beyond that point, the proportions are those recommended in the boiling process.

Unbroken flax straw is more easily deprived of its wood, if carbonate of soda be used in the boiling process, instead of caustic soda. Whenever unbroken straw is used, the acid-bath must be followed by immersion in carbonate of soda, for a few minutes, as the acid, otherwise, will lodge in the tube, and injure the fibre.

Very fine samples of long flax, after breaking, may be obtained in the same way; the liberated carbonic acid having a tendency to divide the flax fibres, and to fit them for fine heckling, after soaping.

---

In steeping, or boiling, it is important that the caustic soda and the acid should be equally and intimately mixed with the water, in the proper proportions. As this cannot be done, conveniently, by agitating the water in the vessel, when filled with flax, the commixture must either take place in another vat of similar dimensions, and the solution be transferred to the one containing the fibre; or a plan shewn in Fig. VI. must be adopted. *c*, Fig. VI., is a pipe, leading from a cistern, or reservoir of water; *d* and *e* are two tubs, the one containing acid, the other alkali. Each of these, by means of a small cock and tube, discharge their contents into the water-pipe *c*, during the passage of the water through it. The cock *f*, in the pipe *c*, being opened simultaneously with either of the small ones, the liquids immediately become intimately mixed in the water-pipe, and are poured, in that state, into the tank. The cocks belonging to the tubs are purposely of such dimensions, that, if opened to their full extent, they would discharge more of the acid and alkali than would be necessary; they must, therefore, be regulated, so as to keep the mixture as near as possible to the degree of Twaddell required.

A very little experience will demonstrate the extent to which the cocks ought to be opened; and, by collecting the mixed liquids at the end of the water-pipe *c*, and testing them with the hydrometer, the proper strength can be maintained.

The quantity of acid or alkali to be stored in the tubs *d* and *e*, must be regulated by the capacity of the vat. A common cask, with the usual materials for cocks, may contain the alkaline solution, however strong; but, the acid must be diluted considerably before it is put in a wooden vessel, and the cock, through which it is admitted into the pipe *c*, should be of lead, earthenware, glass, or gutta percha.

To prepare an acid solution indicative of 1° of Twaddell's Hydrometer, specific gravity 1·005, one measured part of acid must be mixed with 320 parts of water. This is the strength required for the boiling process. To prepare a solution indicative of 2° Twaddell, specific gravity 1·010, one part, by measure of commercial acid, is mixed with about 160 parts of water; and, for 3° Twaddell, specific gravity 1·015, one part of acid, and eighty parts of water, are required.

The quantities of water necessary for the reduction of caustic soda to its proper densities, may be known from the following table, which is sufficiently correct for technical purposes.

To reduce one part, by measure, of caustic soda, of the following densities, down to 2° Twaddell, specific gravity 1·010.

| Twaddell | Spec. Grav. | Water by measure | Twaddell | Spec. Grav. | Water by measure |
|---|---|---|---|---|---|
| 24° | 1·120 | 14·0 parts | 13° | 1·065 | 8·0 parts |
| 23° | 1·115 | 13·5 ,, | 12° | 1·060 | 7·5 ,, |
| 22° | 1·110 | 13·0 ,, | 11° | 1·055 | 7·0 ,, |
| 21° | 1·105 | 12·5 ,, | 10° | 1·050 | 6·5 ,, |
| 20° | 1·100 | 11·5 ,, | 9° | 1·045 | 5·37 ,, |
| 19° | 1·095 | 11·0 ,, | 8° | 1·040 | 4·25 ,, |
| 18° | 1·090 | 10·5 ,, | 7° | 1·035 | 3·62 ,, |
| 17° | 1·085 | 10·0 ,, | 6° | 1·030 | 3·0 ,, |
| 16° | 1·080 | 9·5 ,, | 5° | 1·025 | 2·5 ,, |
| 15° | 1·075 | 9·0 ,, | 4° | 1·020 | 2·0 ,, |
| 14° | 1·070 | 8·5 ,, | 3° | 1·015 | 1·0 ,, |

It will be seen, that, in the preceding table, which has been drawn up from experiment, there is some little divergence from the theory of proportion; this, however, is of little importance, as it, very probably, arose from the condition of the water, or the temperature of the liquids, at the time of each experiment; to which influences, the workmen will always be subjected.

By mixing equal parts of caustic soda, of 2° Twaddell, and of water, a solution, indicating 1° Twaddell, is obtained.

---

The caustic soda may be made in the way usually adopted by soap-makers; but the quickest, and, perhaps, the best method is the following:—

Two parts of good recently-burnt lime are slaked with about six parts of hot water; the hydrate, thus formed, is added, gradually, to a solution of two parts of soda ash, in twelve parts of hot water, stirring the materials carefully.

On mixing the lime and soda carbonate together, the carbonic acid of the latter leaves it, to combine with the lime, with which it forms an insoluble carbonate. This compound is allowed to deposit, and the clear supernatant liquid holds the caustic soda in solution.

According to theory, 100 parts of carbonate of soda would only require 40·5 of burnt lime; but, in practice, it is always desirable to use, at least, equal parts; and, if the process be conducted in the cold, even a larger proportion of lime should be employed.

To ascertain whether the solution of soda is caustic, a small quantity is filtered, and added to clear lime water. If no cloudiness is produced, the causticity is complete; but, if the fluid becomes milky, or turbid, more hydrate of lime is required for the abstraction of the whole of the carbonic acid, from the soda.

The causticity may also be tested by taking a little of the filtered liquid, and adding some weak acid, such as muriatic acid, diluted sulphuric acid, or even vinegar. If no effervescence ensues on the addition of the acid, the carbonate of soda has been completely decomposed by the lime. It is necessary to filter the liquid, or the test may prove fallacious; for, any portion of carbonate of lime floating in it will produce effervescence, when attacked by the acid.

The soda-ash should be first carefully crushed, and then dissolved by the aid of heat. This is best done by placing it in a *wicker basket*, suspended in a boiler of hot water; this prevents the formation of hard and almost insoluble cakes at the bottom of the boiler.

In preparing caustic soda, less water than that specified should not be used, *as very concentrated solutions of the* *alkaline carbonates are not affected or decomposed by lime.* Carbonate of potash, for example, when dissolved in only four parts of water, is not affected by lime; when five to eight parts of water are present, slight decomposition takes place; but, it is only when it is dissolved in at least ten parts of water, that the causticity of the whole is effected.

Soda carbonate is more easily decomposed by lime, than the potash salt; but, yet, practically, it is always better to have an excess of water, so that the law of substitution may be more easily fulfilled.

In fact, although the carbonates of potash and soda, when dissolved in large quantities of water, are decomposed by hydrate of lime, yet, carbonic acid has, really, a much more powerful affinity for those alkaline bases, than it has for lime; thus, fire drives off all the carbonic acid from carbonate of lime, yet, no amount of heat can cause it to leave either potash, or soda.

Even this intense attraction, however, is overcome, under certain circumstances, by the powerful agency of that law, which, when an acid is presented to two, or more bases, compels it to choose the one with which it forms the most insoluble compound. Not only is this the case when the acid happens to be *free*, but, even when it is already *in combination;* and, in obedience to this law, an acid will leave a base, for which it has the *highest attraction*, but with which it forms *a soluble salt*, to unite with a substance for which its *affinity is less,* but with which it forms *an insoluble compound.*

If it be necessary to concentrate caustic alkali, by evaporation, it is improper to do so while any carbonate of lime is present; for, strong caustic potash, or soda, will decompose carbonate of lime; and thus, instead of obtaining hydrate of soda, we shall only produce a carbonate of that alkali. For the same reason, if *concentrated* solutions of hydrate of soda are deficient in causticity, it is improper to add lime, unless after the previous dilution of the alkali with large quantities of water.

The difficulties of which workmen complain, in making caustic soda, and which they ascribe frequently to the bad quality of the lime, are generally to be traced to their ignorance of these laws.

Caustic soda must be carefully *covered up from the air;* and, after the removal of the supernatant liquor, the deposited carbonate of lime must be washed with fresh water, as long as any indication of alkaline power can be obtained from it.

The introduction of cocks, at different heights, in the vessel, enables the workman to draw off the clear liquid, without disturbing the carbonate of lime. These cocks should be at the distance of, about, six or eight inches from each other. This arrangement will be found very serviceable wherever a liquid has to be removed, without disturbance to any sediment beneath it.

---

The amount of absolute soda, in the soda-ash of commerce, varies so much, that it is desirable, where large quantities are consumed, to subject it to some test. This is done by a process called *alkalimetry,* the *rationale* of which consists in saturating a sample of the alkaline salt, by means of an acid of known strength, and noting the quantity of the latter required. Thus, the stronger and better the alkali, the more acid will be required to neutralise it.

A test acid of normal strength is first prepared, and placed in a vessel, called an alkalimeter. This apparatus consists of a glass tube, about fourteen inches high, and half an inch in diameter and capable of holding more than 1000 grains of distilled water. It is graduated into 100 divisions, each holding exactly ten grains of water.

From this vessel the acid is to be poured or dropped into the alkaline solution under examination, until, by the employment, alternately, of reddened and of blue litmus paper, it is ascertained that the exact point of neutralisation has been attained. By reading off the number of measures of acid removed from the alkalimeter, the strength of the soda-ash is known.

The acid employed is generally sulphuric, of such specific gravity, that one thousand grains measure, or, the contents of the one hundred divisions of the alkalimeter, represent exactly forty grains, or one equivalent of pure acid. A thousand grains of this acid, or, the contents of one hundred divisions, will saturate fifty-four grains, or, one proportion of carbonate of soda, or thirty-two grains of pure soda.

To prepare this acid, for the purpose of alkalimetry, a pure anhydrous carbonate of soda must be obtained, by subjecting bicarbonate of soda, for a little while, to a red heat, without fusion, in a platinum crucible. Dissolve fifty-four grains of this salt in about an ounce of water, and mix, in another vessel, one part, by measure, of the best sulphuric acid, and eleven or twelve parts of water.

When the acid mixture has cooled down to 60°, fill the alkalimeter up to 0°, and drop its contents, gradually, into the solution of carbonate of soda, stirring briskly all the time, until by the application of reddened and blue litmus paper, the exact point of neutralisation has been ascertained.

If the acid be of the proper density, the one thousand grains will be required to neutralise the fifty-four grains of carbonate of soda; but, supposing it requires only fifty measures of the acid to neutralise the fifty-four grains, then, by adding water to the remaining fifty measures, or, five hundred grains, in the akalimeter, until the liquor stands at 0°, a test acid is obtained, one hundred measures, or, one thousand grains of which contain exactly sufficient to neutralise an equivalent, or 32 grains of soda. A bottle filled with the acid, thus prepared, must be labelled, "*test acid.*"

In the next place, fifty grains of the soda-ash are weighed, and dissolved in warm water, and the solution filtered. The acid from the alkalimeter is then carefully added, and the mixture constantly stirred with a glass rod, until, by the use of litmus paper, blue and red, the point of neutralisation is ascertained. The quantity of acid used, is then read off. Before finally testing it with litmus paper, the mixture should be heated nearly to boiling.

As 1,000 grains, or 100 measures of the test acid neutralise and indicate 54 grains of pure carbonate, and 32 grains of absolute soda, it is very easy to calculate, by a common rule of arithmetic, the quantity of real alkali in any given sample.

The most convenient form of alkalimeter is the one modified by Dr. Normandy.

---

That weak caustic soda, even when heated, does not injure vegetable fibre is well known; in fact, in all our systematic books on Chemistry, we are taught, that to obtain pure lignine, we are, among other steps, to boil, first, in weak caustic soda, and, then, in acid.

Dr. Ure remarks,* that even cotton "fibre is not injured in caustic soda, of 3° Twaddell, and under a pressure of ten atmospheres of steam, or specific gravity 1·015, though it has increased to double the density in the course of the boiling by the escape of steam: or by being boiled under the atmospheric pressure, at 14° Twaddell, or specific gravity 1·070."

It has even been proved, recently, that the immersion of fibre in the *strongest possible solution* of cold caustic alkali, so far from injuring it, absolutely gives it *greater strength and tenacity.* For the publication of this fact, with its results, a medal was awarded by the Council of the Great Exhibition, to Mr. Mercer.

The employment of sulphuric acid has been urged, also, as a great objection to the Claussen process; but this arises from an ignorance of the technical applications of that compound. Claussen is not the only one who uses it in contact with fibre, inasmuch as bleachers do and have used it for a very long period. When it was first introduced, about the middle of the last century, the public

* *Dict. Arts, Manufactures, and Mines,*—Art. Bleaching.

were much alarmed, until Dr. Home published a volume on Bleaching, and showed that "he had kept linen in a *strong sour of oil of vitriol* for many months, and that the cloth was as strong, after it was taken out, as when it was put in."*

Bleachers commonly use a much stronger solution of sulphuric acid than any recommended by Claussen for his process; and yet, their experience proves, that, with ordinary care, it can exert no injurious influence on fibre; in fact, it is known that even cotton fibre "may be dipped in sulphuric acid of specific gravity 1·070, or Twaddell 14°; or may be steeped, for eighteen hours, in sulphuric or muriatic acid, of specific gravity 1·035, or 7° Twaddell, without its strength being impaired."†

* Parke's *Chemical Essays.*

† Dr. Ure—*Dict. Arts, Manufactures, and Mines.* Art. Bleaching.

## PART III.

Average Price of Flax.—The Product of a Ton of Flax Straw.—In preparing Flax Fibre for Cotton, the Expenses of Scutching are obviated.—Cost of Scutching in various Parts.—Conversion of refuse Tow into Cotton.—Flax Wool.—Milling and Felting Properties.—Cutting Flax into Lengths.—Character of a Flax Fibre.—Means for giving Parallelism to Tow before Cutting.—Heckling and Cutting Machines.—Steeping the Fibre.—Boiling.—Description of the Apparatus used in the Processes of Cottonising and Bleaching.—The Solutions employed.—Methods of testing the Liquids. — Chloriscopy. — Chlorimetry. — The Chemical Decompositions occurring in each Vat. — Washing, pressing, and moulding the Fibre.—Method of Drying.—The Process applicable to Hemp and Filamentous Fibres.—A Modification of it applicable to Animal Fibres, and especially to Silk.—Mode of economising the Materials used in the Vats.

If the average price of flax, quoted by the Royal Flax Society, be correct, more money can be realised by cottonising the whole produce of the straw, long and short fibres included, than by expending that time and labour upon it, which are necessary to fit it for the hands of the linen manufacturer.

Good flax straw contains one fourth, and, in some instances, one third of its weight, of fibre; and yet, the united evidence of our most practical flax manufacturers proves, that only about one eighth can be obtained, in the state of long line.

Thus, to produce one ton of long flax, no less than eight tons of straw are consumed, with an expenditure of time, and of labour, which may well enhance the price of the material.

Some specimens of flax, thus produced, with so much labour, and at so great cost, may realize a high price; *but the average is fairly stated to be* £50 *per ton.*

The remaining portion of the fibre, in the eight tons of straw, is either wasted, or converted into comparatively valueless tow. The shoves, from the scutching machine, which are often burnt, contain, frequently, 35 *per cent.* of their own weight, of fibre—*too short it is true for tow, but long enough for cotton.*

The practical yield of a ton of straw, seems to be, on the average, 2½ *cwt.* of flax, and 1 *cwt.* of tow. Much of the deficiency may be accounted for, in the shove waste, which seems to be considered perfectly useless.

The average price of tow may be stated to be about £7 per ton. If the flax straw, then, contains from 25 to 35 per cent. of fibre, of which only about 11·5 are fitted for the linen-maker, while the great bulk is either wasted, or converted into tow, not worth more than £7 per ton, where is the absurdity of having recourse to a process, in which, every particle of fibre, long or short, can be made available in the manufacture of an article realising £56 per ton; and which, if even driven into competition with the low qualities of cotton, will still equal, in monetary value, the average long flax?

The Claussenising process recognises no difficulty in the inequality of the fibre found in straw; every portion is obtained and used; and for every particle of fibre, a price is obtainable, equal to that quoted as the average price of even long flax.

Nor is this all. It would be something in favour of the Claussenising system, if it realised a *greater* "yield" at the *same expense*, but, it does more, it obtains *a larger produce*, and at a *much smaller cost*.

The expense of manufacturing one ton of flax cotton, from the straw, including "*breaking*," "*cutting*," "*steeping*," and "*bleaching*," does not equal the single item of "*scutching*" as now practised in the preparation of long flax.

Mr. Fergus, M.P., perhaps the largest manufacturer of flax, in Scotland, estimates the cost of "*scutching*" to be £14 per ton.

In Ireland, where labour is so amazingly cheap, the cost of scutching *low priced flax* is not less than 1*s*. per stone, or £7 per ton.*

Mr. Deman, one of the instructors of the Royal Flax Society, gives the following statement of the cost of scutching in Belgium:—

"On the Blue System;"
"Scutching, £12 per ton."

"On the Courtray System;—*Summer Bleaching*;"
"Scutching," £20 per ton.

"On the Courtray System;—*March Bleaching*;"
"Scutching, £25 per ton." †

* *Letters on the Cultivation of Flax.* By J. H. Dickson. London: R. Groombridge and Son. 1846.

† *Flax, its Cultivation and Management, etc.* By E. F. Deman London: James Ridgway, and E. Wilson.

When straw is treated for the preparation of flax-cotton, "*scutching*" is unnecessary; and, therefore, *the expense of that process is entirely avoided.*"

---

Although it is thus capable of proof, that the whole of the flax fibre may be Claussenised with advantage, yet, for the present, or as long as the supply will allow it, this part of the Claussen process will be confined to the conversion of refuse tow into flax cotton. Such tow as that, which has hitherto been consumed, for this purpose, in the Chevalier Claussen's works at Stepney, may be obtained, in immense quantities, at from £4 to £7 per ton.

The term flax-wool has been applied to a material employed for mixing with natural wool; but, as it is prepared from the same materials, and in precisely the same way as flax-cotton, the latter term will, for the future, be alone employed in this treatise. The difference, in the process of manufacture, between the flax designed for woollen goods and that prepared for cotton machinery, occurs after the termination of its treatment by the Claussen process; with the single exception, that the fibres, intended for the woollen manufacturer, are not cut so short as those designed for factitious cotton.

Flax-cotton can be "*milled*" and "*felted;*" and, for this reason, is perfectly fitted for admixture with wool, and other animal fibres, in the manufacture of hats, flannels, broadcloth, and the *staple fabrics* of the woollen districts. This, alone, gives to flax-cotton an immense superiority over natural cotton, which does not possess felting properties, and cannot, when employed with wool, be intimately mixed with it by carding or spinning.

The felting and milling power of wool is said to depend upon its curved, or twisted form; but, upon what depends the felting or milling property of flax cotton? If the felting, or milling, were merely indirect or secondary actions, caused by the flax fibres being embraced, and drawn together by the twisted wool, in its act of corrugation, then, natural cotton ought to be amenable to the same influence. This, however, is not the case; natural cotton will neither mill nor felt, except to a very slight degree; and only, when the form of its fibres is in the act of changing, under the influences of certain agents, such as *caustic soda of high density*, the necessity for whose employment will forbid its commixture with animal matters. Claussen believes that the milling and felting power in flax wool depends upon its peculiar electrical condition, resulting from his process.

---

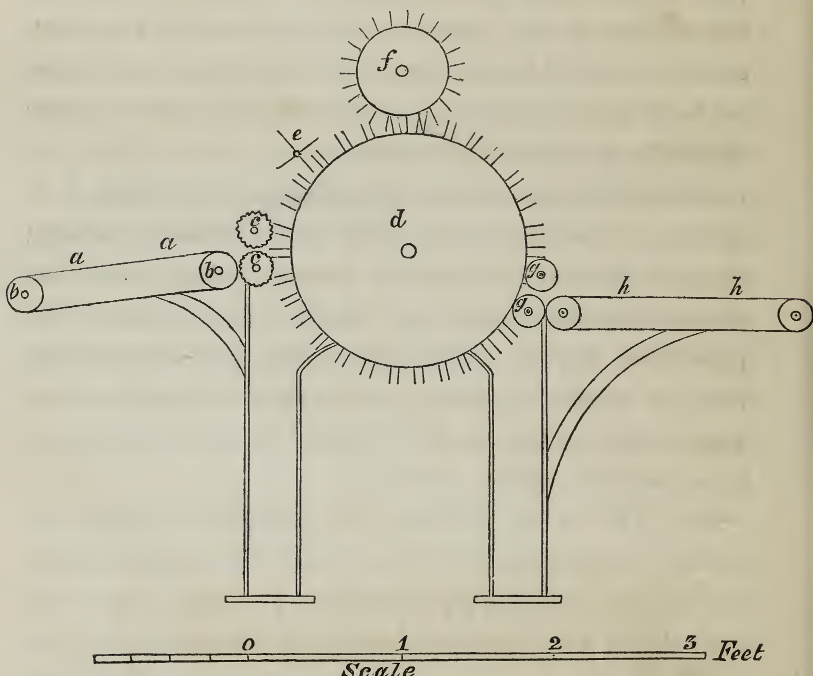
A most important step in the Claussenising process is, the division of tow into suitable lengths, in accordance with the staple required. This is necessary, not merely to fit the flax for cotton machinery, but, also, for the perfect splitting of the fibres.

A single fibre of raw flax is composed of a great number of exceedingly small filaments, which, in some samples, are so fine, as to be almost microscopic. These are bound together in the form of a fibre, by means of an exceedingly adhesive substance. If a piece of flax, which has been boiled in caustic soda, and afterwards dried, be drawn between the thumb-nail, and the side of the index finger, the end of the fibre will split into numerous filaments, giving the extremity a brush-like appearance; but, if the fibre be a long one, this mechanical action will not produce a complete separation throughout the whole of its extent. So, also, it is found, by experience, that the force of the carbonic acid gas, used by Claussen, cannot exert a *certain and decided influence* throughout a greater length than a few inches. For this reason, therefore, uncut tow would be only *partially Claussenised,* many of its fibres being split only at the ends, and, still retaining their integrity, or unity, in the middle.

Antecedent, however, to the process of cutting, it is necessary to bring the tow fibres into a parallel position; as the existence of a loop, for example, would render the section imperfect, as far as length is concerned. This parallelism may be effected in several ways—such as, by hand, or machine heckling, as practised in tow factories; by a process similar to that adopted in wool-combing, or by a machine, called a *spiral gill.*

Fig. VII. is the drawing of a machine intended for combing or heckling the tow. A side view is given, with the framing taken off, and exhibiting an end view of all the rollers: *a a* is a towel, moved by the rollers *b b,* on which the tow is laid, and delivered by it to the fluted rollers *c c;* from these it is caught by the revolving toothed drum, or circular heckle *d,* the four-armed flyer *e* pressing it between the teeth of the heckle. It is, then, passed between the large drum *d,* and the smaller heckle *f,* both moving in the same direction, but at different speeds, thereby causing the fibres of the tow to be laid parallel. The tow is then carried onward to the rollers *g g*, at which point of the drum, the teeth of the large heckle recede, by a compensating motion. After passing through the rollers *g g*, the straightened tow is deposited on the towel *h h*, from which it may be either delivered into the cutting machine direct, or be rolled into an endless lap.

Fig. VII.




The annexed engravings, Fig. VIII., IX., and X., represent machines, patented by Mr. James Lackersteen, for dividing flax fibre into suitable lengths, by means of circular cutters, with an action similar to that of shears. The cutters, on each shaft, are loose, but are compelled to revolve with the shaft, by a feather running along its whole extent, and fitting into slots, in each cutter. The cutters on the top and bottom shaft overlap each other, as will be seen by the engravings, and, are arranged at equal distances, by bosses, of certain thickness, which will be regulated according to the lengths into which the flax is to be divided. The cutters and the intermediate bosses, on the top shaft, are tightened against each other by means of a nut on the shaft, against a shoulder on the opposite end, but independently of the cutters on the lower shaft, which are tightened in a similar way. As the cutters and bosses, on both shafts, are of the same dimensions, that is, equal in thickness and diameter, each cutter, on one shaft, will be in actual contact with its fellow on the other shaft; and, as the cutters wear a little, the bottom shaft is brought forward, by tightening the two nuts of the crosshead, fixed on one side of the frame, in a line with the lower shaft, and into which the end of the shaft works, as will be seen by the plan in the engravings. The flax is supplied to the machine by endless bands.

Fig. VIII.

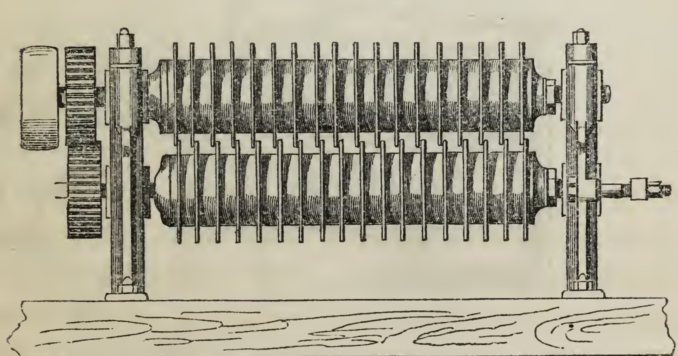


Fig. IX.

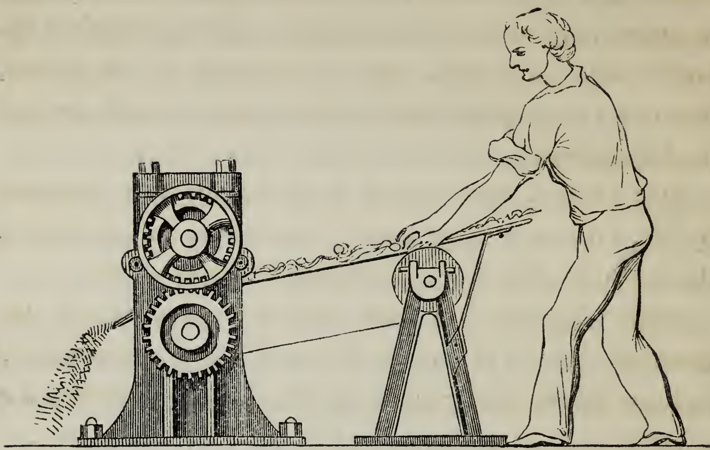
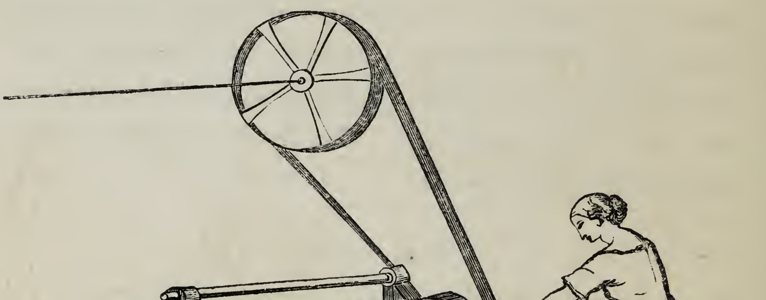


Fig X.



In a circular cutting machine, constructed by Mr. Donkin, for the Patent Flax Company, the discs are kept in proper approximation by means of spiral springs on the lower shaft. The flax, also, is conveyed to the knives, between two endless bands, which grasp it, and prevent its derangement.

Fig. XI. is a front view of a cutting machine, designed by Mr. Frederick Moore, and intended to be annexed to the machine, Fig. VII., for straightening the tow.

After the tow has been rendered parallel, by the machine, Fig. VII., it is delivered by a succession of endless towels, and rollers, to the moveable shears, *a a*,

Fig. XI.

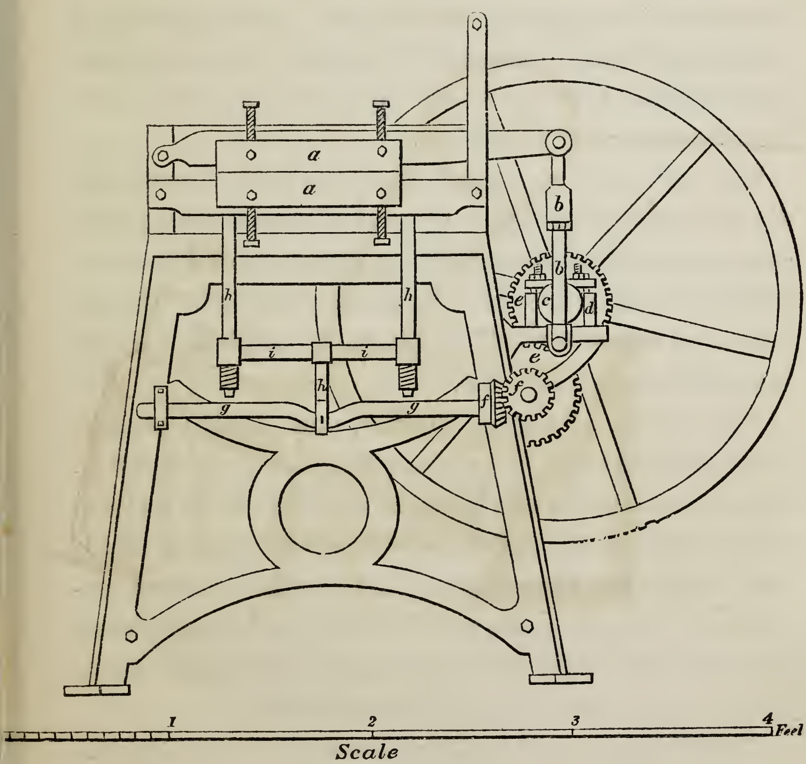


Fig. XI., which are worked by the connecting rod, *b*, and crank, *c*, supported in the plummer-blocks, *d d*. The spur-wheels, *e e*, and mitre-wheels, *f f*, act upon the crank, *g*, which, by means of the rods, *h h h*, and cross-head, *i*, prepare the tow previous to its entering the shears. By an arrangement in the machine, the tow, after entering a given length between the shears, is held fast, until the section is made.

The tow, having been heckled and cut, is, at once, conveyed to a large vessel, or tank, containing a cold solution of caustic soda, of 1° Twaddell. After remaining in this state for a period of twenty-four hours, it is removed to a steam-vat, similar to the one described in Fig. VI. with the exception that no divisions or frames are required, to keep the tow straight. After admitting a solution of caustic soda, of 1° Twaddell, heat is applied, and ebullition kept up from two to four hours, the shorter time being generally sufficient.

The cold steeping, antecedent to ebullition is necessary for the easy and complete removal of certain nitrogenous compounds, whose coagulation, if treated with hot water, at first, would render that task more difficult. If time be not an object, the cold steeping and the ebullition may take place, in the same vat.

The process of boiling the tow, must be the same as that adopted in the case of long flax, except in duration. After ebullition in caustic soda of 1° Twaddell, for two, instead of four hours, the tow is ready for removal to the vats, where the Claussenising and bleaching are accomplished. In boiling flax, or tow, which has been previously steeped in any of the existing processes, common carbonate of soda may be used instead of caustic soda.

In the steeping and boiling processes, to which reference has just been made, tons of tow may be, with advantage, treated in the same vat, and in one operation; but, in splitting, and bleaching, smaller quantities must be employed; and, therefore, vats of less dimensions are required.

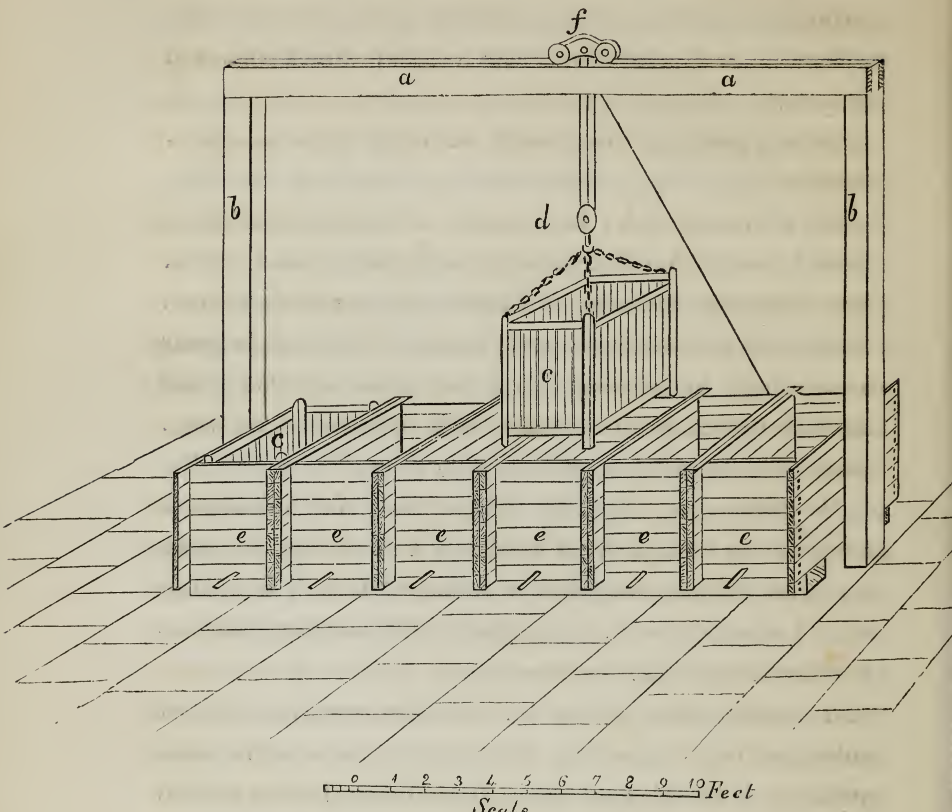
The experimental vats used at Stepney, and represented in Fig. XII, contain only two hundred and fifty gallons of water each; but, vessels of about treble their capacity would be found very convenient, and would enable the manufacturer to Claussenise two or three cwt. of tow in each operation; and, although this may appear to be a very small quantity, yet it must be recollected that the operation is repeated with surprising rapidity. Thus, each vat being supplied with a moveable cradle, the tow is introduced, first, into Vat 1; in a few minutes it is passed on to 2, a fresh cradle of tow taking its place in 1. As the process goes on, the cradle in 2 is moved to 3; 1 succeeds to 2; and, again, a fresh cradle of tow is introduced into Vat. 1, and so on.

In working this process on the large scale, instead of increasing very materially the quantity of tow in each operation, it would, perhaps be desirable to have a double or treble set of vats. These might be arranged in a circle, with a circular railway over all, for the purpose of moving the cradles from vat to vat.

Fig. XII. represents six vats, *e e e e e e*, ranged side by side, with a travelling railway, *f*, over head; *c c*, are the cradles; *d*, the fall and block for hoisting them, worked by a small windlass, not seen; *a a*, the railway; *b b*, the frame-work to support it.

The vats are rather more than half filled with the following cold solutions:

Fig. XII.




1. Solution of soda-ash, or carbonate of soda.
2. Solution of sulphuric acid in water.
3. Solution of soda-ash, as in 1.
4. Solution of hypochlorite of magnesia.
5. Solution of soda ash, as in 1 and 3.
6. Solution of sulphuric acid in water, as in 2.

The Vats, 1, 3, and 5, contain alkaline solutions of precisely the same strength; the soda ash being present in the proportion of about 5 per cent.

The Vats, 2 and 6, contain water, acidulated with sulphuric acid, in the proportion of about 1½ per cent. of the latter.

Vat 4, contains a solution of hypochlorite of magnesia, indicating about 3° Twaddell, specific gravity 1·015. An imperial pint of this liquid contains 29·5 grains of chlorine.

As a general rule, the amount of acid and alkali, in Vats 1 and 2, should be such, that equal measures of the two solutions, when put together, will produce effervescence, and a perfectly neutral liquid. This may be easily ascertained, by mixing equal measures together; and, after warming, testing by means of red and blue litmus paper.

Workmen soon become accustomed to the mode of ascertaining the proper strength of the solutions, by taste, or sight. Thus, when tow is removed from 1 to 2, there should always be a slight degree of effervescence, indicated by the escape of gas bubbles to the surface of the liquid; there ought, also, to be a decided improvement in the colour, owing to the conversion of the iron oxide into a sulphate. The absence of either of these phenomena indicates a deficiency in the strength of one, if not of both these solutions. The strength of the bleaching-fluid is also easily determined by a practical man, by observing the rapidity of its action on tow.

The liquids in Vats 2 and 6, should always possess a slightly *acid* taste, and should exercise a decidedly acid reaction on litmus paper. On the contrary, Vats 1, 3, and 5, should possess *alkaline* properties, shewn, for instance, by restoring the blue colour of reddened litmus paper. The solutions 1, 3, 5, should also be tried occasionally by means of fresh acid in small glass vessels, to ascertain whether effervescence occurs.

The liquids contained in the vats do not require frequent changing; although the quantity and quality of each have to be kept up by repeated additions. For this purpose, concentrated solutions of soda ash, and of hypochlorite of magnesia, are kept prepared. The commercial sulphuric acid, of course, serves to strengthen Vats 2 and 6.

The employment of an hydrometer, to ascertain the density of the different solutions, would not serve to determine the true quantity of the ingredients, *except when first prepared, and before they have been used.* In the working solutions, the true strength of the ingredients can only be learned by chemical analysis. Thus, the process of analysis called alkalimetry, already described, serves to point out the true quantity either of soda-ash, or of acid, in the alkaline and acid vats.

The reason why the hydrometer is useless when the liquid has been once used, is, that in all the vats new compounds are continually being formed, by the reaction of the solutions on each other; and these would, of course, interfere with the indications of the instrument.

There are several technical methods of ascertaining the condition of the bleaching-liquid, in Vat 4. Some of these have relation solely to its comparative strength; others indicate the definite proportions of chlorine present. The first are merely chloriscopic, the second chlorimetric.

The chloriscopic tests only indicate the *presence* of chlorine, without determining its *quantity*. They are, however, extremely serviceable to the workman, because, by their aid he is enabled to ascertain whether a liquid is quite deprived of its bleaching force; by the same agency, also, he discovers whether the fabric or fibre which has been decolorised and washed, *is perfectly free from chlorine.*

The two most valuable chloriscopic tests are the alcoholic solution of *gum guaiacum*; and the mixture of clear white starch, with iodide of potassium, in distilled water. The first is the best test, because it is less liable to fallacy.

On adding a solution of guaiacum to a liquid containing chlorine, a deep blue precipitate is immediately formed, which does not change when dried. Even when the quantity of chlorine is extremely small, a distinctive pale blue precipitate results.

When it is desirable to ascertain whether a fabric or fibre has been well washed after bleaching, it is necessary first to dry a portion of it, and then to moisten it with clear water. On dropping a little of the guaiacum liquor upon it, the minutest portion of chlorine is detected by the blue colour resulting.

It seems almost impossible to remove the *last* trace of chlorine from bleached goods, without exposure to the air, or warmth, for a short time. In all cases where the chloriscopic solution of guaiacum has been applied to the fabric, or fibre, *before drying*, traces of chlorine have been discovered; although, after drying, the slightest indication could not be seen.

Concentrated sulphuric acid causes a pale *green* precipitate with guaiacum; but it cannot, for a moment, be confounded with the *blue* of the chlorine liquid. Diluted nitric acid also, although it does not, *at first*, produce any change, when in contact with guaiacum, some hours after, communicates first a green, then a blue, and finally a brown colour. The slowness of the action, however, distinguishes the nitric acid, from chlorine.

A mixture of a solution of iodide of potassium, and of perfectly white starch, is also *chloriscopic;* but, as there are several agents which are capable of liberating the iodine of the iodide of potassium, this test is less certain than the preceding one. A weak solution of sulphate of indigo, may also be used chloriscopically. If chlorine be present in sufficient quantity, the liquid will be decolorised, or, rather, will become yellow.

Several chlorimetric formulæ have been given, for ascertaining the amount of chlorine in any bleaching solution, or compound; but, those most generally adopted, are the following:—

Select a number of clean dry crystals of the proto-sulphate of iron (green copperas), and, after washing them with alcohol, expose them to the air until perfectly dry, and free from the alcoholic odour. Dissolve 78 grains of these crystals in about 2 ounces of water, and acidulate with a few drops of sulphuric acid. The chlorimetric action depends upon the peroxidation of the protosalt of iron, in the green sulphate; and for the 78 grains, exactly 10 grains of chlorine are required.

Next, fill a graduated vessel, such as the alkalimeter, with a known quantity of the bleaching liquid under examination; then pour it gradually into the iron test solution, stirring briskly until the iron is peroxidised; this may be known by dropping a portion of the mixed liquids into a solution of the red prussiate of potash, or by testing with paper, previously impregnated with that salt in solution. As long as any protosalt remains, a blue precipitate is seen in the solution of red prussiate of potash, and a blue colour is given to the test-paper impregnated with that salt; but, when all the iron is peroxidated, the blue colour is no longer produced, either on the paper, or in the red prussiate solution; the process is therefore complete. The presence of the green colour, on the addition of the test, is of no consequence; the blue, alone, is to be regarded.

The red prussiate solution for this experiment, may be placed, in spots, on a clean white earthenware plate; this will do away with the necessity of preparing test-paper.

It is now necessary to read off the number of measures of bleaching liquor, which have been required to accomplish this purpose, and to remember that the quantity employed, contained exactly 10 grains of chlorine.

The same process is applicable to the examination of chloride of lime. Take, for example, 50 grains of that compound, diffuse it in 1,000 grains of water, in an alkalimeter, and add it to the iron test-liquor as before.

As chlorine escapes during the operation, the experiment may be performed in a phial, corking it up, and shaking it after every addition of the bleaching liquid.

Another method, proposed by Gay Lussac, depends upon the conversion of arsenious into arsenic acid by the influence of chlorine,

One hundred grains of arsenious acid are dissolved in 2,000 grains of pure strong hydrochloric acid; distilled water is then added, until the whole occupies the volume of 7,000 grains of water. 1,000 grains measure of this test-liquor contains nearly 14·29 grains of arsenious acid, requiring for its conversion into arsenic acid, 10 grains of chlorine.

One thousand grains of this test-liquor are to be placed in a deep glass, and sufficient sulphate of indigo added to give it a distinct blue colour.

From an alkalimeter, or similarly graduated vessel, pour the bleaching liquor, under examination, gradually, stirring briskly all the time, until the blue tinge of the sulphate of indigo is destroyed. The moment this takes place, the action is complete; the whole of the arsenious acid being converted into arsenic acid. The quantity of bleaching liquid required for the change, indicates 10 grains of chlorine.

Another process may be adopted by the workman, with great advantage, inasmuch as it enables him, not only to ascertain the state of the bleaching vat, but, also, serves to guide him in the addition of the concentrated hypochlorite of magnesia, for the purpose of renovating its strength.

Several two-ounce white glass phials, cast in the same mould, and therefore of equal diameter, are first to be fitted into holes, drilled in a piece of wood, so that they can stand upright. Then, by means of a minim measure, sixty drops of the peracetate of iron, a liquid much used by dyers and calico-printers, are to be placed in each phial.

Prepare four or five different solutions of fresh bleaching liquid, from 4° or 5° of Twaddell, downwards; and fill up each bottle with a separate solution. The peracetate of iron produces, with the chlorine, a deep red colour; the intensity increasing with the strength of the bleaching fluid. These bottles, which must be labelled, serve, therefore, as indicators; and, by taking a bottle of exactly the same size, and placing within it exactly the same quantity of peracetate of iron as in the indicator, and then filling it up with the vat liquid, its strength may be ascertained approximately, by comparing it with that indicator, whose shade of colour it most nearly resembles.

So, therefore, when renovating the bleaching vat, by the addition of the concentrated hypochlorite of magnesia, the proper strength may be ascertained by the same means.

In preparing the indicators, it may be as well to provide one, for at least every fourth of a degree of Twaddell.

The peracetate of iron should be prepared with colourless acetic acid, in the following way:—Dissolve iron filings, or turnings, in a mixture of equal parts of muriatic acid and water; and, to ensure saturation, a large excess of iron should be kept in contact with the solution, for some time, at the temperature of 212°. Mix one measure of this liquid, at 40° Twaddell (specific gravity 1·200), with an equal measure of strong acetic acid. This constitutes the peracetate of iron.

The tincture of guaiacum of the chemist's shops may be used in the same way as the per-acetate of iron, although it will not admit of so wide a range. Hypochlorite of magnesia of 14° Twaddell, specific gravity 1·070, throws down a dark blue precipitate, when guaiacum, in solution, is added to it; but the colour entirely disappears in a few minutes. At lower densities, such as from 3° Twaddell, downwards, the blue colour of the precipitate is persistent; and, as its intensity is in proportion to the strength of the bleaching liquid, it may be used as a test, or indicator.

The flax remains in Vat 1 during the time necessary for perfect saturation; and, as it was already in a wet state, when placed there, the capillary forces are assisted, and the solution of the soda-salt soon permeates the whole of the fibres. The cradle is now hoisted to the top of the vat, and the tow allowed to drain for a few minutes.

The cradle is next lowered into Vat 2, where an immediate change in the physical character of the fibre takes place. The sulphuric acid, coming in contact with the carbonate of soda, with which the fibre is impregnated, combines with the alkaline base, to form sulphate of soda; and, the carbonic acid being liberated, assumes its gaseous condition, exerting, at the same moment, its well known enormously elastic power. The development of this expansive force, among the minute filaments, forming each normal fibre of flax, accomplishes their instant separation; the adhesive bond of union having been previously weakened by the antecedent steps in the operation.

That the segregating power of this gas is necessary to the cottonising effect, is evident from the fact, that if, after boiling in caustic soda, the tow be washed, and dried, without exposure to carbonic acid, each fibre will return to its normal condition; the adhesive matter, among the filaments, retaining sufficient power, when dry, to bind them together, as at first.

The cradle ought to remain in Vat 2 as long as bubbles of carbonic acid continue to rise quickly to the surface, showing, that the decomposition of the soda salt is going on. The workmen, at the same time, should move the tow about, by means of poles of ash wood. The operation, in this vat, generally occupies a period of from ten to fifteen minutes. The cradle is then raised, and the tow allowed to drain.

The fibre is next immersed in Vat 3, where, again, the development of carbonic acid takes place, owing to the decomposition of the soda salt, by the excess of acid brought from Vat 2.

The action of the solution in Vat 3 is threefold. It promotes the further separation of the filaments, by giving up carbonic acid ; it neutralises any adhering sulphuric acid, and prepares the fibre for the bleaching operation in Vat 4. The cradle is removed from this solution, after the lapse of four or five minutes, and the fibre is allowed to drain.

It is now ready for the important operation of bleaching, and for this purpose is transferred to Vat 4.

To understand the nature of the change which takes place in Vat 4, we must remember that the fibre leaves Vat 3, saturated with carbonate of soda. Vat 4 contains a solution of hypochlorite of magnesia. The composition of the contents of the two vats is as follows :—

Vat 1, carbonate of soda, consisting of 1 equivalent of carbonic acid, and 1 equivalent of soda.

Vat 2, hypochlorite of magnesia, consisting of 1 equivalent of hypochlorous acid, and 1 equivalent of magnesia.

*Hypochlorous acid* is composed of 1 equivalent of chlorine, and 1 equivalent of oxygen, the two most powerful bleaching agents known.

On introducing the cradle into Vat 4, two equivalents of the carbonate of soda, with which the fibre is charged, immediately re-act on two equivalents of hypochlorite of magnesia, and two atoms of carbonate of magnesia, and one of hypochlorite of soda are formed. At the same time, the hypochlorous acid of the second equivalent of hypochlorite of magnesia is resolved into its constituents, chlorine and oxygen ; each of which having an intense affinity for the hydrogen of colouring matter, combines with it; hydrochloric acid, which unites with the other atom of soda, and a compound of oxygen and the hydrogen of colouring matter being formed; thus:—

2 Na O, $CO^2$+2 Mg O, ClO+Colouring matter=2 Mg O, CO  Na O, ClO+Na O, HCl+Oxygenated colouring matter. (HO?)

After the whole of the carbonate of soda brought from Vat 3, has been decomposed, the bleaching action of the hypochlorites of magnesia and of soda still goes on; and the hypochlorous acid, being influenced by the disposing affinity of the colour in the fibre, yields its chlorine and oxygen to it.

The length of time necessary for the operation of bleaching varies very considerably, according to the character of the tow. After the fibre itself is sufficiently decolorised, the whole mass appears to retain a dark orange colour, owing to the presence of shove wood; but, as it is unnecessary to continue the bleaching action after the fibre becomes sufficiently white, (the wood being removed by after-processes of manufacture), the cradle may be hoisted, and the fibre drained.

Generally speaking, fifteen or twenty minutes suffice for the bleaching process. The workmen should continually move the fibre about, for the purpose of exposing every part to the action of the chlorine; and great care should be taken that no large masses remain unopened.

In working upon a large scale, it may be necessary to make the bleaching a separate operation. Thus, the cottonising, or splitting, may be accomplished in Vats 1, 2, and 3; and then the tow may be removed to a second, and even a third set of vats, for the purpose of bleaching: this will prevent the delay arising from the difference in the length of time occupied in Vat 4, and the preceding ones. Vats 4, 5, and 6, are all bleaching vessels.

After draining the tow out of Vat 4, it is next immersed in the carbonate of soda, in Vat 5.

The tow brings with it a surcharge of hypochlorite of magnesia from the preceding operation; and, as in Vat 4, two equivalents of hypochlorite of magnesia are re-acted upon by two equivalents of carbonate of soda, the same results follow. The action of these vats, however, is soon expended; as the whole of the hypochlorite of magnesia is almost immediately decomposed, while this resulting hypochlorite of soda is too feeble for active bleaching.

After careful draining, the cradle is immersed in Vat 6, which contains water acidulated with sulphuric acid.

In this vat, the carbonate of magnesia adhering to, and remaining within the fibre, is decomposed by sulphuric acid, with the evolution of carbonic acid,—sulphate of magnesia being formed. This action promotes the further separation of the flax filaments; any remaining hypochlorite of soda, also, is decomposed; and the fibre is ready for draining and washing.

For the purpose of being washed, the fibre may be, at once, conveyed to vessels, where an abundance of water may be obtained; or, it may be first rinsed or steeped in a solution of "antichlorine" (bisulphite of soda), and then washed in water.

The washing should be continued, until, upon drying a piece of the fibre, and exposing it to the action of a drop of the chloriscopic solution of guaiacum, no green or blue colour is produced.

The value of the preceding processes of bleaching and splitting is very much enhanced by the fact, that only one insoluble compound is formed throughout, namely, the carbonate of magnesia; and, *that* is completely redissolved in Vat 6; while, during its conversion into soluble Epsom salts, it, by giving off carbonic acid, contributes to the perfect splitting of the fibres.

The old system of bleaching by chloride of lime is perfectly unfitted for the cotton process, on account of the danger of forming in the fibre, while souring, an insoluble sulphate of lime, the harshness produced by which can never afterwards be removed; if muriatic acid be used for souring, the difficulty of removing the resulting hydroscopic salt is found to be practically much greater, than, from its soluble character, would be supposed, and, therefore, imperfect drying is the result.

The last water, in which the cotton is rinsed, should contain a weak solution of soap.

---

For some purposes, the fibre does not require bleaching to perfect whiteness; in which case the following process is alone necessary:—

The tow, on being removed from the steeping or boiling vat, is saturated with water, holding in solution 5 per cent. of sulphate of magnesia. It is then immersed in Vat 1 of the series, containing a solution of soda ash. In this vat, the sulphate of magnesia, within the fibre, is decomposed by the carbonate of soda; sulphate of soda and carbonate of magnesia being formed. On removing the tow to Vat 2, containing sulphuric acid and water, the carbonate of magnesia, within the fibre, is decomposed—carbonic acid is liberated, and sulphate of magnesia formed.

By thus forming a carbonate within the fibre, instead of merely saturating it with the solution of the normal salt, a singular bleaching effect is produced; and, on immersing the fibre in Vat 2 among the acid, a most perfect splitting action is obtained. From Vat 2, the tow passes to the washing and soaping processes.

Although fibre, thus prepared, is not absolutely white, yet it is sufficiently so for all ordinary purposes. It is also perfectly fitted for dyeing operations, requiring no other preparatory bleaching; having already, in the short process to which it has been subjected, attained a greatly increased capacity for imbibing and retaining colouring matter.

---

After the final washing, the cotton is thrown into moulds of perforated wood, or of wicker-work, to be made into cakes about two feet long, one foot wide, and two inches thick. In this mould the cakes are pressed by means of a lever, whose fulcrum is immediately behind the cotton, and which, passing over it, is made to press a board upon its whole surface. From the mould, the cakes are removed, at once, to a pair of horizontal wooden squeezing rollers, kept in contact with a weighted lever. The cakes are passed through these rollers, and are thus deprived of nearly all their water.

When a plentiful supply of water, from an elevation, can be obtained, the following plan of washing the cotton will economise labour very considerably. The cotton, having been placed in a vat, a wicker or latticed cover should be fitted over the top, to prevent its being washed away. A powerful stream of water is then admitted at the bottom of the vat; and, as it wells up through the masses of fibre, and runs over the sides of the vessel, or by an exit or waste pipe, it will wash away, most effectively, all traces of foreign matters, or chlorine.

For the purpose of drying the cotton, the following arrangements are best. A room or chamber is heated by any convenient plan, up to about 150° *Fahr.*; means being adopted for allowing the free exit of watery vapour. About two feet above the floor, a wooden grating is placed, upon which the cotton can fall, and through which the heated air can circulate. In an opening in the wall of the heated chamber, a toothed "*devil*," capable of performing 1000 or 1500 revolutions, per minute, is so placed, that the wet cotton can be put into it, through a feeder, from the outside. The "devilled cotton," on leaving the machine, is projected some distance into the chamber, and as it descends like flakes of snow, is exposed to the desiccating action of the hot air. As it falls, also, lightly, in a heap, the heat can easily come in contact with every portion of the fibre.

A large machine, called a "*willow*," may be advantageously used, to break up the cake, before the introduction of the cotton into the "*devil*."

With the operation of drying, the privileges of the Claussen processes terminate; as the long flax, in one case, and the flax-cotton, in the other, are then ready for the manipulation of the flax, cotton, or woollen manufacturer.

It may be proper to remark, that the patentee claims the use of any suitable acid, whether known, and sold commercially, or obtained by the fermentation of any substance. He also claims the use of any substance, which, like *alum,* has the power of decomposing a carbonate, and setting free carbonic acid gas. Finally, he claims the adaptation of gaseous expansion, of whatever kind, and however obtained, to the separation of the filaments of vegetable and animal fibre.*

Although, in the preceding pages, mention has been made merely of flax, and flax-tow, yet, hemp and all filamentous fibres are amenable to the same processes; while, by pursuing the method indicated, either for long line or for cotton, according to circumstances, an immense number of fibrous plants, and portions of plants, such as Manilla-hemp, jute, aloe, pine-apple-leaf, and many others, may be rendered available for textile and paper-making purposes.

A modification of the same process is also applicable to animal fibres, and especially to certain descriptions of silk, whereby their value and beauty are much enhanced. The application of the process, however, to animal matters, is the subject of a second patent.

---

In Vats 2 and 3, the union of soda and sulphuric acid, results in the formation of the well-known salt, sulphate of soda. As in working the Claussen process upon a large scale, a very considerable quantity of this compound is created, it may be important to collect it. This can only be done, economically, by allowing the liquid, from the vats in question, to run into large shallow tanks, where spontaneous evaporation may take place; or, where the employment of waste steam may accelerate the process.

* Appendix D.

The Chevalier Claussen proposes to render the concentrated solution of sulphate of soda serviceable in the manufacture of the caustic soda, to be used in the steeping-vats. The plan which he adopts is the subject of an unspecified patent, and therefore, not yet ready for publication.

With the exception of the compounds formed in Vats 2 and 3, no other materials, worth collecting, are to be found, as the result of the process. In Vat 6, certainly, sulphate of magnesia is produced, by the action of sulphuric acid on the carbonate of magnesia, brought from Vat 5 by the fibre; but, it will not repay the labour, time, and plant. necessary for its conservation.

## PART IV.

Claussen's Method of Bleaching quite unique—The Hypochlorite of Magnesia long known as a Bleaching Agent—Dr. Ure's Remarks upon its Properties, and Mode of Preparation—Claussen's Method of preparing it quite novel—The Process of Bleaching by double Decomposition—The Steps of the Process required for Bleaching Linens—The increased Capacity for imbibing Colouring Matter resulting from the Process.

CLAUSSEN'S method of bleaching differs, so remarkably, from all others, that a minute description of the process will be useful.

*In the first place*, he has succeeded in using a bleaching agent, whose superior powers have been long acknowledged, but whose services, hitherto, could never be made available in practice.

*Secondly.* He has introduced a new and exceedingly economic mode of preparing the hypochlorite of magnesia, the salt to which reference has just been made.

*Thirdly.* In the operation of bleaching, he disposes his materials in a way peculiar to himself, and essential to the production of a safe and rapid result.

Dr. Ure, in speaking of chloride or hypochlorite of magnesia, remarks, that this salt was long ago proposed by Sir H. Davy for bleaching linen, as being preferable to chloride of lime, because the resulting muriate of magnesia was not injurious to the fibre of the cloth, as muriate of lime may be, under certain circumstances. I prepared a quantity of chloride of magnesia, by exposing a hydrate of that earth in the chlorine chamber of a large manufactory of chloride of lime at Glasgow, and obtained a compound possessed of considerable decolouring powers; but I found that the chlorine was so feebly saturated by the base, that it destroyed the colours of fast-dyed calicoes as readily as chlorine gas or chlorine water did, and was therefore dangerous for common bleaching, and destructive in clearing the grounds of printed goods, which is one of the most valuable applications of the calcareous and alkaline chlorides. The occasion of my making these experiments was, the importation of a considerable quantity of magnesite, or native atomic carbonate of magnesia, from the district of Madras, by an enterprising friend of mine. Encouraged by the encomiums bestowed on the chloride of magnesia, by many chemical writers, he expected to have benefited both the country and himself by bringing home the earthy base of that compound, at a moderate price, but was disappointed, to his cost." *

The very same difficulties, which Dr. Ure thus describes, were encountered by the Chevalier Claussen, at the commencement of his experiments; but they all disappeared before the advantages gained by his mode of preparing, and his manner of using the salt.

The following is Claussen's formula for the preparation of hypochlorite of magnesia:—

Dissolve one part, by weight, of chloride of lime, or diffuse it thoroughly through twelve parts of water.

* *Dictionary of Arts, Manufactures, and Mines.*

In a second vessel, dissolve also two parts of sulphate of magnesia, in twelve parts of water.

Mix the two solutions together, and agitate them well for fifteen or twenty minutes, and then allow the sulphate time to precipitate. The supernatant liquid is the concentrated solution of hypochlorite of magnesia, which, when mixed with water, forms the bleaching liquid of Vat 4. This solution must always be kept covered from the air; and to prevent disturbance to the sulphate of lime which is deposited at the bottom of the vessel, cocks must be placed at different altitudes, as recommended under the directions for making caustic soda. The cocks should be of earthenware, glass, or gutta percha.

The chloride of lime of commerce consists of one equivalent of hypochlorite of lime, and one equivalent of chloride of calcium; therefore, for every part of commercial chloride of lime, *two parts* of Epsom salts must be used, to supply sufficient sulphuric acid for the precipitation of the lime of the hypochlorite, and the calcium of the chloride, after that metal has been oxidated. The best way, perhaps, of explaining the oxidation of the calcium, is to consider that an atom of water suffers decomposition during the change.

The term, "*muriate of magnesia*," is therefore used in the formula instead of "*chloride of magnesium*"; thus:

$$\text{Ca O, ClO} + \text{Ca Cl} + 2\ \text{Mg O SO}^3 + \text{HO}, = 2\ \text{Ca O, SO}^3 + \text{Mg O, ClO.} + \text{Mg. O, HCl.}$$

The peculiarity of the mode of using the bleaching materials in the Claussen process, depends upon the removal of the fibre or fabric from vat to vat, *without intermediate washing*. In this way certain compounds are allowed to react upon each other, and to form new salts *in the heart of the fibre itself.*

If the fabric to be bleached be linen, the following are the steps in the process, without, however, any reference to mechanical arrangements for transferring the cloth from vat to vat; this being left to the judgment of the operator.

The same routine is applicable to yarns and fabrics. Cotton goods require weaker solutions.

The cloth is first boiled for a period of four hours, in caustic soda, of 2° Twaddell, specific gravity, 1·010; it is then drained, and, without washing, steeped for an hour in water acidulated with sulphuric acid, of 1° or 2° Twaddell, specific gravities 1·005, 1·010. The higher strength is required when the cloth, after "bucking" in the previous operation, is very dark in colour. It has already been shewn, that acid of 1° or 2° Twaddell, cannot injure the fibre; and that even cotton may be steeped, without injury, in sulphuric acid 7° Twaddell, specific gravity 1·035, for eighteen hours.*

For the next steps in the process, a series of vats are prepared, of the same character, and charged with solutions of the same strength, as those employed for the manufacture of flax cotton. In Vat 2, however, about two per cent. of white argol is to be mixed with the acidulated water, for the purpose of forming a tartrate of iron, and thus preventing the precipitation of its oxide on the cloth, in any of its subsequent exposures to alkali.

The vats being prepared, the fabric is transferred from vessel to vessel, in the same way as that described in the cottonising process. If, however, the operation of bleaching in Vat 4 does not seem to progress, it is then advisable

* Dr. Ure, and others.

to transfer the fabric into Vat 3, or 5, for the purpose of exposing the hypochlorite of magnesia, *once more,* to the reaction of carbonate of soda. After the lapse of a few minutes, it is again removed to Vat 4; and so on until the removal of the colour is complete.

The influence of what the Chevalier Claussen terms "*bleaching by double decomposition,*" is very remarkable. Frequently, when hypochlorite of magnesia appears almost inert, and the colouring matter of the fibre, fabric, or yarn, shows no disposition to yield to the bleaching agency, the mere passing the material from vat to vat, and the establishment of a series of combinations and decompositions in the fibre itself, gives full activity to the decolorising forces, and accomplishes, in a few minutes, more than simple immersion in the hypochlorite itself would do, during a period of hours.

Again, if any material be placed at once in hypochlorite of magnesia, without previous saturation in some salt, capable of reacting on the bleaching compound, not only will the action be slower, but there will be risk of injury to the fibre. Whereas, by adopting Claussen's plan of "*double decomposition,*" the power of the hypochlorite (dangerous, under the old method of application, as shown by Dr. Ure), is modified and governed: while, at the same time, its decoloring effects are promoted and hastened.

The favourable development of the bleaching forces, produced by "*double decomposition,*" is not confined to the use of hypochlorite of magnesia, nor to the reaction of carbonate of soda merely, on that salt. The bleaching power of hypochlorite of lime (chloride of lime), as well as of all other compounds of the same class, is promoted by their subjection to the same phenomena as those which have been described, in connexion with the magnesian salt.

In some cases, where the fabric, or yarn, contains much colouring matter, a bleaching liquid of 6° Twaddell, specific gravity 1·030, and holding, in solution, 59 grains of chlorine to the imperial pint, may be safely used: taking care, however, to change the fabric, or yarn, frequently, from vat to vat, without allowing it to remain more than ten minutes, at one time, in the hypochlorite of magnesia.

At a very early period in the history of his invention, Claussen directed public notice to the fact, that fibres, yarns, and fabrics, treated by his process, received an increased capacity for imbibing and retaining colouring matter; and that, by his mode of treatment, flax and linen became capable of receiving those tints, the communication of which, by the dyer, or calico printer, had, heretofore, been considered impossible.

## PART V.

Prejudices against Growth of Flax.—Circumstances which make a Crop exhaustive.—Value of Linseed Feeding.—Flax formerly grown either for Seed, or Fibre alone.—Other Causes, beside its supposed exhaustive Character, formerly prevented the Cultivation of Flax.—Difficulties attendant on the Steeping Process.—The Expense of transporting Straw to a Distance.—These Obstacles obviated by the Claussen Process.—The Fibre ought to be the only Medium of Exhaustion.—Composition of pure Vegetable Fibre.—Commercial Flax Fibre never quite pure.—Analysis of Fibre.—Comparative exhausting Powers of Wheat.—Barley.—Oats.—Rye.—Beans.—Turnips.—Potatoes.—Cabbage and Flax.—Causes of the Discrepancy which appears in the Analysis of the Flax Plant, by different Chemists.—Amount of inorganic Matter in Linseed.—Amount of inorganic Matter in the entire Flax Plant.—Analysis of Flax Straw.—Amount of fertilising Force removed from an Acre of Land by the whole Flax Crop.—Foreign Imports of Flax, Linseed, and Oil Cake.—Importance of the Home Cultivation of Flax.

It was a prevalent opinion, at one time, that flax was an exceedingly exhausting crop; and for this reason, the farmer, in many old leases, is forbidden to grow it.

Not only flax, however, but all other plants are exhaustive, if they are periodically removed away from the locality, on which they are grown, instead of being consumed upon the spot, or returned, in some shape or other, to the parent soil.

For example, if a crop of flax be pulled, and carried away entirely—the straw to the steeping pits, and the seed to the crushing mills—the land is deprived of a very large amount of its fertilizing force, and the result is, of necessity, a certain degree of exhaustion. If, on the contrary, the seed, in its normal state, or, even after the oil has been extracted from it, be given as food to cattle, upon the spot, a very large proportion of the original matter of the soil is returned to it, augmented in fertilizing power by the azote and other substances, which had not been derived from the land, in the first instance.

By thus using the seed as food, the land is more than compensated for the support rendered by it, to the whole crop.

In former days, from which the prejudices against the growth of flax may be dated, the employment of seed, as cattle food, especially in the form of oil-cake, was but little practised. Flax was grown under two aspects;—either solely as a seed crop,—or, as a mere fibre-yielding plant.

In the former event, the seed was not removed until after full maturation; the fibre, in that case, being considered almost worthless; but, in the latter instance, the crop was gathered in its green state, and with its seed immature, and, probably, doomed to be wasted. In either of these aspects, flax might have been, with propriety, denominated "*an exhausting crop.*"

So highly valued, however, in the present day, is linseed, as cattle food, and so fertilizing is it, in its state of fæcal transition, that the growth of flax for food alone is satisfactorily remunerative. The Right Honourable Mr. Christopher, M.P., Chancellor of the duchy of Lancaster, a gentleman of great experience in agricultural matters, stated, the other day, at the head of a deputation to the President of the Board of Trade, that several of his "friends and tenants were growing flax, *for the seed alone*, and, were realising, by such means, quite as much as from any other description of crop." The sale of the straw must, therefore, in such a case, be considered profitable.

Apart, also, from the supposed exhausting character of flax, other causes, until recently, have existed as obstacles to the cultivation of that plant. The principal, were, *first*, the trouble and uncertainty attendant upon the process of steeping, if performed by the grower; and, *secondly*, the difficulty and expense of transporting so bulky an article, as the straw, to any distance, for the purpose of obtaining a market.

These obstacles are obviated by the Claussen process; for by the employment of the farmers' "*breaking machine*" described in Figs. IV., and V., the weight and bulk of the straw are so much reduced, that it may be sent to market, as easily, and under circumstances, surely as favourable, as far as transport is concerned, as those which attend the carriage, to different parts of the kingdom, of the imported foreign flax and hemp, for which this country pays upwards of eight millions, *per annum.* Another obstacle to the growth of flax, was the danger of a complete loss being incurred, in case of a failure in the length of the crop. A short dwarf flax would be useless to the linen manufacturer, and the farmer would lose all his time and labour: but under the Claussen system, the shortest flax is available, and saleable.

Two highly beneficial results of the Claussen process, may be consistently pointed out in this place: namely, the retention, on the land, of the wood or boon removed by the "*breaker*," to be used with cattle food, or not;

and, the permission given to all growers, to allow the full maturation of the plant to occur, before harvesting it; thus securing a much more valuable and productive seed, whether for feeding, sowing, or crushing.

From what has been stated, it is evident, that under proper arrangements, the fibrous portion of a flax crop ought to be the only medium of exhaustion.

Vegetable fibre, when absolutely pure, merely consists of the three organic elements, Carbon, Oxygen, and Hydrogen, none of which are *necessarily* derived from the land; and which, do not, certainly, represent any portion of what is usually considered to be the fertilizing force of any soil.

Commercial flax fibre, however, is never perfectly pure, as it always carries with it certain inorganic compounds derived from the ground upon which it has been grown: the amount removed, however, is, comparatively speaking, very small, as will be seen from the following statements:—

One of the most successful exponents of agricultural chemistry, Dr. Hodges, of Belfast, in a paper read before the "Meeting of the Council of the Chemico-Agricultural Society of Ulster," some time since, states:—

"I procured, several months ago, by the kindness of the Secretary of the Royal Flax Society, a specimen of remarkably fine flax fibre, from a sample which had obtained the first prize at the exhibitions of the Fax Society, at Ballinasloe and Belfast. That sample, I presumed, might safely be taken as representing the fibre in the purest form in which it is presented to the manufacturer.

"As the details of the analysis would interest only the chemist, it is unnecessary to describe them. The method which I followed is that taught by my esteemed friend, Dr. H. Will, Extraordinarius Professor of Chemistry in the University of Giessen. It may, however, be useful, for the information of those who are not familiar with the processes of the laboratory, to mention, that every plant, when exposed to a strong heat, in the crucible of the chemist, is found to consist of two parts—a part which is combustible, and flies away, being composed of the elements which the plant, during its growth, had derived from the air; and a fixed incombustible ash, containing the materials supplied by the soil. The pure flax fibre, if possessing the composition usually assigned to it, should, when burned in the open crucible, totally disappear, without leaving any solid residuum. The first step in my experiment was, therefore, to ascertain whether that substance, when heated, as I have described, left any incombustible earthy matter. A portion of the fibre, dried at 212°, was burned in a clean platinum crucible, and ignited, until all organic matter had been burned away, when there remained in the crucible a quantity of a very light bulky ash, which possessed the same slightly yellowish white tinge which the fibre exhibited. A qualitative examination of this ash showed, that it contained the following ingredients of the soil—iron, lime, magnesia, soda, chlorine, sulphuric acid, phosphoric acid. One hundred parts of the dry flax fibre I found to contain 0·54 parts of ash, so that two and a half hundred weight of dressed flax would contain rather more than a pound and a half of the ingredients of the soil.

"A quantity of ash was prepared, from the same sample, and was found to possess the following composition, in the hundred parts :—

| | |
|---|---|
| "Carbonate of lime . . . . . | 62·00 |
| Sulphate of lime, gypsum . . | 7·15 |
| Phosphate of lime . . . . . | 13·66 |
| Oxide of iron . . . . . | 3·99 |
| Carbonate of magnesia, with traces of chloride of sodium (common salt) . | 2·00 |
| Silica . . . . . . . . | 11·20 |
| | 100·00." |

It is evident, therefore, from the analysis of Professor Hodges, that if two tons of straw, containing one-fourth of fibre, "*of all sorts*," be grown on an acre of land, the amount of inorganic matter abstracted from the soil by means of the fibre, alone, will only be 6 lb. *per acre.*

That this quantity is comparatively small, will be seen from the following examination of the amount of fertilizing compounds taken from the land, by other familiar vegetable substances:—According to Professor Johnston, a crop of wheat, bearing at the rate of 25 bushels, per imperial acre, and weighing 60 lb. per bushel, takes from the land, per acre, 210 lbs. of inorganic matter, consisting of the following substances:—

| | In Grain. | In Straw. |
|---|---|---|
| Potash . . . . . . . | 7·15 . . . | 22·44 |
| Soda . . . . . . . | 2·73 . . . | 0·29 |
| Lime . . . . . . . | 0·85 . . . | 12·09 |
| Magnesia . . . . . . | 3·63 . . . | 6·89 |
| Oxide of Iron . . . | 0·20 . . . | 2·35 |
| Phosphoric Acid . . . | 15·02 . . . | 5·54 |
| Sulphuric Acid . . . | 0·07 . . . | 10·49 |
| Chlorine . . . . . | . . . | 1·97 |
| Silica . . . . . . . | 0·35 . . . | 117·94 |
| | 30 lbs. | 180 lbs. |

If the straw be returned to the land, as manure, the amount of inorganic matter removed by the grain is 30 lbs.

A crop of barley, of 40 bushels to the acre—each bushel weighing 53 lbs., takes from the land,—

| | |
|---|---|
| In the grain . . . . . | 53 lbs. |
| „ straw . . . . . | 160 |
| Total . | 213 lbs. |

A crop of oats, of 50 bushels per acre, each weighing 42 lbs., takes,—

| | |
|---|---|
| In the grain . . . . . | 32 lbs. |
| „ husk . . . . . | 30 |
| „ chaff . . . . . | 54 |
| „ straw . . . . . | 210 |
| Total . | 326 lbs. |

A crop of rye, at 26 bushels per acre, each weighing 54 lbs., removes—

| | |
|---|---|
| In the grain . . . . . | 30 lbs. |
| „ straw . . . . . | 170 |
| Total . | 200 lbs. |

A crop of beans, of 25 bushels per acre, weighing 2800 lbs., carries off—

| | |
|---|---|
| In the bean . . . . . | 40 lbs. |
| „ straw . . . . . | 170 |
| Total . | 210 lbs. |

A turnip crop, of 20 tons to the imperial acre, takes from the soil 650 lbs. of mineral matter :—

| | |
|---|---|
| In the bulbs . . . . . | 340 lbs. |
| „ tops . . . . . | 310 |
| Total . | 650 lbs. |

A crop of eight tons of potatoes, carries away from the soil, 580 lbs. of inorganic matter:—

| | | |
|---|---|---|
| In the tuber | . . . . . | 400 lbs. |
| „ top | . . . . . | 180 |
| | Total . | 580 lbs. |

The drum-head cabbage, sometimes, yields 50 tons, to the imperial acre, and removes nearly a ton of mineral food from the land: a crop of only 20 tons, removes about 900 lbs from the soil.

Some little discrepancy appears in the analysis of the flax plant, by various chemists; but this seems to arise from the fact of the several examinations having occurred at different ages of the plant, and with varying quantities of moisture.

Professor Johnston and Sir Robert Kane state the amount of inorganic matter yielded by the flax plant to be from 4½, to 5½ per cent: while Sprengel and others find much less.

In obtaining so high a result, the first two chemists no doubt operated upon straw pulled in an unripe condition; for, under the old system, as it is termed, in opposition to Claussen's, unripe flax was preferred. Unripe flax straw, in drying, loses from 55 to 65 per cent. of weight; therefore, such a change would reduce the actual per centage, *one half.* Or, even supposing that the experiments were made on *mature flax*—the mere drying—for, it is expressly stated, that "*dried straw*" was the material operated on—would reduce the weight, and per centage, nearly one half.

The average of a great number of experiments made by the author on fresh-pulled flax, indicates the amount of inorganic matter to be—

| | | |
|---|---|---|
| In the seed | 2·50 | per cent. |
| „ straw | 1·60 | „ |

Flax, after being kept some time, loses very considerably in weight by the removal of water; therefore, the quantity of inorganic matter on analysis will appear much greater.

Sprengel states the inorganic matter of flax seed to be 2·340 per cent.; therefore, a crop of 20 bushels per acre, each bushel weighing 56 lbs, takes from the land about 26¼ lbs. of inorganic matter, consisting in the 100 parts, of—

| | |
|---|---|
| Potash | 17·59 |
| Soda | 6·92 |
| Lime | 8·46 |
| Magnesia | 14·83 |
| Oxide of Iron | 1·25 |
| Phosphoric Acid | 36·42 |
| Sulphuric Acid | 2·47 |
| Chlorine | 0·17 |
| Silica | 10.58 |
| | 98·69 |

One hundred parts of the ashes of the *entire* flax plant are composed of—

| | |
|---|---|
| Potash | 11·78 |
| Soda | 11·82 |
| Lime | 14·85 |
| Magnesia | 9·38 |
| Alumina and Oxide of Iron | 7.32 |
| Phosphoric Acid | 13·05 |
| Sulphuric Acid | 3·19 |
| Chlorine | 2·90 |
| Silica | 25·71 |
| | * 100·00 |

* Sir Robert Kane, M.D.

According to Sprengel, 100·000 parts of the flax straw, without the seed, contain 1,456 parts of mineral matter, consisting of:—

| | |
|---|---|
| Potash . . . . . . } Soda . . . . . . } | 510 |
| Lime . . . . . . | 230 |
| Magnesia . . . . . | 480 |
| Alumina . . . . . . | 2 |
| Oxide of iron . . . . . | 10 |
| Silica . . . . . . | 20 |
| Chlorine . . . . . | 20 |
| Sulphuric acid . . . . | 66 |
| Phosphoric acid . . . . | 118 |
| | 1,456 |

If, for the sake of example, we suppose the product of an acre of land to be two tons of straw, and 20 bushels of seed, each bushel weighing 56 lb., then, it appears that the amount of inorganic matter taken from the soil will be:—

| | |
|---|---|
| In the seed . . . . . | 26¼ lb. |
| „ straw . . . . | 65¼ „ |
| Total | 91½ lb. |

It is evident, therefore, from the foregoing statements, that flax, if removed entirely away from the ground, is not so exhaustive as many other, well-known, and popular crops; while, from the feeding value of its seed, and the facilities which Claussen's method affords for retaining nearly all the straw on the spot, it promises to be one of the most generous and valuable productions of the soil.

English agriculturists ought to be reminded that the imports of foreign flax into the English market are enormous. According to the statement of the Chevalier Claussen,* "the imports of foreign flax increased from 936,000 cwts. in 1831; to 1,800,300 cwts. in 1842."

1,800,300 cwts., or 90,015 tons, the produce of 720,120 tons of straw would require 360,060 acres of land. This quantity of straw alone, unmanufactured, and exclusive of the seed, would realise to the English farmer, *if grown at home, two millions, one hundred and sixty thousand, three hundred and sixty pounds sterling.*

"This sum would include the straw alone; for linseed, under the items of—

"Seed for crushing,
"Seed for sowing, and
"Oil cake,

England pays, annually, to foreign countries, nearly three millions more.

"The extended home-cultivation of flax, however, would be productive of benefit, not merely to our complaining agriculturists, but also to thousands of our labouring poor. A high authority † pointedly remarks that, 'It is especially desirable so to apply the productive power of the soil for the supply of articles as indispensable to the support of millions of our people as corn itself; and an additional inducement to the growth of flax, beyond that offered by other articles, may be found in the fact, that to bring it to the same condition as that in which it is usually imported from foreign countries, calls for the employment of a considerable amount of human labour. There is no part of the United Kingdom in which the flax plant cannot be successfully cultivated.'"

* Flax Movement.—E. Wilson.

† Mr. G. R. Porter, Secretary to the Board of Trade.

# APPENDIX A.

---

*Copy of* Lady Moira's Letters, *extracted ftom the first volume of the printed "Transactions of the Society of Arts."*

---

Sir,—I had the pleasure of your letter, yesterday, by Doctor Halliday; Lord Moira and I, with much satisfaction, desire to be ranked as subscribers to the "Sylva," which is to be re-published by Dr. Hunter, whose "Georgical Essays" have been greatly admired beneath this roof. As to the factitious cotton I have attempted to introduce the use of, I flatter myself that it is beginning to answer the purpose I had at heart—some alleviation to the miseries of the unhappy beings that surround me. The excess of poverty that reigns here being such, that, in my native land, I am persuaded it would not be imagined to exist. The very refuse of the flax, which is called the backings of the tow, produces a material that can be manufactured into a coarse, but comfortable clothing of the fustian and cotton kind; and this kind of cotton was offered to me last week for sale, at threepence per pound—it is therefore plain, how little pains and expense the manufacturing of it costs. Wool is here, almost constantly, sixteen pence per pound—often dearer. The wife makes and spins the cotton; the weaver adds a few more yards of warp to the piece of linen he has in his loom for sale, and clothes his family with little more cost than his own industry. It must appear to you that this manufacture, however is best calculated for Ireland, where the consumption of flax must consequently leave such quantities of refuse—for tow and the backings are all I employ, except fired, or mildewed flax, both of which (from being ill-flaked) being improper for the linen cloth, I have made use of. Hemp will also produce a sort of cotton; but it requires infinitely more boiling, and bears a nearer resemblance to wool. It was the codilla that I tried—the backings of that come amazingly cheap, and I believe it will take a better dye than flax.

The main purport in view seemed to me, the divesting the flax of its oil. I tried soap-boilers' lye with very good success, scouring it afterwards, to take off any bad effects of the lime used therein; I then had it tried to be scoured like wool, but found it required that the fermented urine, in that case, should not be mixed with water, and that kelp and common salt were necessary to be added to it: either of these methods do. The boiling of it might, I am sure, be expedited, by having a cover to the iron pot, which might keep in the steam; and care must be taken, as the liquor diminishes, to replenish it constantly. I have boiled some in a mixture of lime-water and salt; this had a harshness in it that more resembles the crispness of cotton; but the scouring of it would certainly deprive it of that quality, and leaving the lime in it, is confidently asserted here, would rot it. I own I doubt that effect, as I imagined that lime, after it is slaked by water, no longer retains its corrosive quality. In India and China, they use it in the washing of linen, as regularly as we do soap.

The tow is heckled, and boiled in small faggots, tied up by a thread, or bit of tow; the backings are carded in thin flakes, rolled up likewise, and tied; after boiling, they open in the same flakes they were carded into, and are washed out, and laid to whiten in that form. I send you, however, a sample of the backings of white flax, that was only boiled four hours, and never laid down to whiten. In the course of this short process, you will see that the material, of which sacking is made, is considerably mended, though, I think, it wants another hour's boiling, and that a week's whitening would have taken off that harshness of the flax it still, in some degree, possesses. It requires being beat, or put into a press, before it is carded on cotton cards, to separate the fibres, which seem to be set at liberty from each other, by a dissolution of some resinous substance in the flax, at the same time that the oil of that plant is converted into a kind of soap. When I mention white flax, I do it in opposition to that, which, being steeped in the bags, has the appellation of *blay;* this, getting a tincture from the heath, has its colour rather fixed, than discharged, by being made into cotton.

You inquire into the result of my pursuits concerning fixing lasting tinctures on linen, The tedious sickness, and, at length, death of a friend, kept my mind for many months this summer in a situation of languor that is a total enemy to the busy occupations of curiosity; and when I resolved to engage myself therein, to keep off unavailing reflections, I found it too late for many herbs I had set down in a list, and that a plat of weld I had planted the autumn before, had never come up. I then employed myself with the purple fish, found on the Newcastle shore. They answered all the smaller experiments mentioned by Reaumur and Templeman; but those Dr. Holland has given in his translation of Pliny, the naturalist, they in no degree correspond to, with all the boiling in lead and salt prescribed by him, they only produced a very ill-looking soap. Though there appears no doubt but the purple wilk found here, is the buccinum of the ancients, it, however, appeared to me, that it was probable they got their colour from some moss they fed upon. It could not be the Archil, which (as I am told) grows much higher on the rocks, than where they lie. I therefore employed a person to search about the places in which they lie, and to get me some of the moss and sea-weeds that grew near them.

My small collection is but just arrived, and I have not had time, as yet, to try whether my conjecture is true, or false.

To the purple, yielded by the Archil, I owed my suspicion, that there might be mosses that would produce stronger and more permanent dyes. I was trying this morning the solution of tin I got from you, and find it as good as the first day. I shall take some of my cotton, finely spun, to Dublin, that it may receive the advantage of being manufactured by a skilful artist in the loom; and I hope soon to send you a sample of it, when properly wove, that may do it credit.

Almost all I have had wove here has been of the coarse kind, and that by weavers, who never had seen cotton.

I am, Sir, with great esteem and regard,
Your faithful, humble Servant,
E. Moira.

When I received, Sir, the favour of your last letter, I daily expected returning to these mountains; and from that expectation, postponed acknowledging it, thinking this place would yield me more leisure than my engagements in town then afforded me. Had I foreseen that my stay would have been extended to the time it was, I should not have been guilty of that neglect.

Since my arrival here, an opportunity has not occurred for my sending a packet before the present one, and now it is eleven o'clock at night, when I am informed, a messenger is to be sent off at five in the morning to Belfast. I have no reason to be vain of the samples I have sent you, they merely shew, that the material of flax cotton, in able hands, will bear manufacturing; although it is my ill fortune to have it discredited by the artisans who work for me. I had in Dublin, with great difficulty, a gown wove for myself, and three waistcoats; but had not the person who employed a weaver for me, particularly wished to oblige me, I could not have got it accomplished, and the getting spun an ounce of this cotton in Dublin, I found impracticable; the absurd alarm that it might injure the trade of foreign cotton had gained ground; and the spinners, for what reason I cannot comprehend, declared themselves such bitter enemies to my scheme, that they would not spin for me. Such is my fate, that what between party in the metropolis and indolence in this place, I am not capable of doing my scheme justice.

That it should ever injure the trade of foreign cotton is impossible; though long accustomed to behold shoes and stockings looked upon in this part of the world by the generality, as quite unnecessary, yet I cannot but think some apparel is requisite; and as the price of wool is so high, and the poverty of the people so great, I did wish to introduce among them that* invention which I saw might be greatly improved, and turn the refuse of flax into comfortable clothing, and by a process so easy that every

* "Swedish invention," in the original MS.—Author.

industrious wife and her children might prepare it, and those who are supposed to adopt this clothing, are such as would not think of manufacturing foreign cotton for themselves and families.

I send you the sample, Sir, of the backings made into cotton, which you see might be manufactured into no bad clothing; and backings of tow, being sold to me at the dearest time at one penny per pound, it is rating it high to say, that at two pence per pound, a person might have it ready to spin.

All the patterns I send you, are of webs now in use, and those I have given away, or that have been worn in my own family, and have worn exceeding well. I should except the small pattern of plush, which was only a few quills that were thrown on at the end of a piece of worsted plush, to see what pile it would produce.

My gown is wove in imitation of a kind of India muslin; and the thread you will see mnst have been strong from the breadth, which is full a yard and a half wide.

I must beg your acceptance of a waistcoat, a very poor imitation indeed of Manchester ingenuity; but the finest spun cotton was used in my gown, and as I have already told you, Sir, that I had a quantity of cotton in town, I intend immediately setting to work, but all in coarse and cheap manufactures, such as may benefit and suit the lowest classes of life, the rich meriting as little to be considered in my scheme of manufactures, from that capriciousness that generally attends them, as they do to be the objects of much attention in any scheme that is to extend its influence to the most numerous part of society.

I am, Sir,
Your much obliged,
And humble Servant,
E. MOIRA.

Montalto, Ballynahgach,
*July* 31*st*, 1775.

# APPENDIX B.

Don Ramon de la Sagra, the intimate friend and associate of Baron Von Humboldt, was the Spanish Commissioner to the Great Exhibition; he was also a member of the Jury, by which the merits of the Claussen process was examined.

This gentleman has just published a small brochure, on the new methods of preparing flax and hemp, in which the invention of Claussen is mentioned with high distinction.* After describing the process of Claussenising flax, he states:—

"Mr. Claussen, que practicó expresamente un gran número de experiencias á mi vista en Londres, me ha dado muestras de todos los resultados obtenidos, en presencia de los cuales no será posible desconocer la *importancia trascendental* de su proceder. Llámole trascendental, porque la mira de Mr. Claussen, trasformando una sustancia textil, hasta ahora solo *peinable,* en sustancia textil *cardable,* tiende nada menos que á librar la Inglaterra de la dependencia en que se halla de los algodones de la América. Sus esfuerzos, unidos á los antes mencionados en favor de la mayor extension del cultivo del lino, van pues, dirigidos al immenso resultado que preocupa el animo y la imaginacion previsora de ingleses."

The following is a copy of the protest of M. Claussen, as well as of the letter of Don Ramon de la Sagra, to which reference has been made:—

*October* 18*th*, 1851.

TO HIS ROYAL HIGHNESS PRINCE ALBERT, K.G., PRESIDENT OF THE ROYAL COMMISSION OF THE GREAT EXHIBITION OF INDUSTRY OF ALL NATIONS, 1851.

May it please your Royal Highness, my Lords, and Gentlemen,

Upon an examination of the awards made by the juries appointed by you under the authority of the Royal Commission, for the purpose of securing an impartial distribution of rewards

* Memoria Sobre Los Nuevos Metodos de enriar y preparar Los Linos y Canamos presentada Al. Excmo. Senor Ministro de Fomento por Don Ramon de la Sagra, Comisario y miembro del Jurado de la Exposicion de Londres. Madrid: Imprenta del Ministerio de Fomento.

to exhibitors in connection with the Great Exhibition of the Industry of all Nations, I find that what is termed a "prize," or second-class medal only, has been awarded to me by the jury in Class IV., in which I exhibited my new process of preparing flax so as to adapt it for spinning and weaving, either upon the ordinary flax machinery or alone, or in combination with cotton and wool upon the existing cotton and woollen machinery. As I consider this award to be totally at variance with the spirit and letter of the instructions given by your lordships to the council of chairmen of the juries, I beg most respectfully to decline to receive the medal so awarded.

With your royal highness's and lordships' permission, I will state the reasons why I cannot consent to receive this honour. The minute of your lordships to the council of chairmen, above referred to laid it down as a rule for the guidance of the jurors, that the great or council medal should be awarded to inventors, and, in the case of works of art, to cases of remarkable and pre-eminent genius. In order that no misapprehension should exist as to your intention on this subject, your lordships illustrated the rule in the following manner:—

"It is obvious, therefore, that in the case of manufactured articles, a mere excellence of manufacture, being, in other words, a mere difference in degree between subjects included in the same class, cannot be rewarded with a council medal without a deviation from the principle of this decision. If, however, there is any novelty of invention or adoption, or any peculiarity in the mode of manufacture, which can also be taken into account, and of which the importance and value shall be judged sufficient, the council medal may properly be given.

"Thus for example, if a piece of linen be exhibited of such remarkable excellence as to be at once, and by unanimous consent, recognised as greatly superior to any other piece of linen in the whole Exhibition, yet, if the ordinary processes only have been employed in its production, and if it be not distinguished by any originality in the design applied to it, it ought not to have a council medal, however great may have been the care and labour bestowed upon it. *But if, on the other hand, a piece of linen of very decided excellence should be produced by a new method, exhibiting advantages not hitherto attained, it would be quite within the* *spirit of the decision in question that such a method should be rewarded with a council medal.*"

Had these instructions been complied with, the "council medal," and not the "prize medal," ought to have been awarded me; because—

1. I exhibited a process of preparing flax for the linen manufacture, by which the preparation is reduced from three or four days, under one of the existing processes, and as many weeks under another, to less than twenty-four hours—the fibre so treated and prepared by me being produced at a less cost, cleaner, stronger, and more uniformly divided, than under either of the above processes, my mode of preparing it being entirely new.

2. Because I exhibited a mode of preparing flax by which it can be spun, woven, dyed, printed, and treated, alone or mixed in various proportions, with cotton or wool, in every respect similar to those materials, upon any and all of the existing cotton and woollen machines, which is also an entirely new invention.*

3. Because I exhibited mixed yarn formed of a mixture of flax and cotton, flax and wool, and flax and silk, neither of which had ever before been produced.

4. Because I exhibited exactly those articles which were laid down as examples for the guidance of the jurors in their award of the council medal, that is to say, several pieces of linen "produced by a new method, and exhibiting advantages not hitherto attained"—two of those pieces being formed entirely of flax prepared upon my new process, and the remaining two of mixed yarns of flax and cotton, also produced by the new method above referred to; and, in addition to the novelty in the preparation of the fibre, they were further produced by a new process, viz., by the employment of cotton machinery, such machinery never before having been employed in the spinning and weaving of flax, or mixed yarns of flax and cotton.

5. Because I also exhibited pieces of flannel and woollen

* Lady Moira's flax cotton *was never subjected to the experimentum netionis of cotton machinery.* Her ladyship tells us in her letters (Appendix A) that she "could not get it spun," etc. Claussen, before the opening of the Exhibition, challenged the test of machinery, and with perfect success, for mere hand-spinning is no indication of success. Lady Moira's experiments were unknown to the jurors, at the time of the award.—AUTHOR.

cloths, dyed, milled, and treated in every respect as wool, and which were formed of mixed yarns as above-named, and woven upon the ordinary woollen machinery, and upon my "circular loom," for which a medal has been awarded me by the jury in Class VI.; such machines never having before been employed in the spinning or weaving of the above-named mixed yarns.

I have also great reason to complain of injustice done me by transferring an exhibitor of a mode of treating cotton and other fibres by a chemical process analogous to my own out of the class in which he exhibited (Class XVIII.), and in which a prize medal only was awarded to him, for the purpose of giving to him a council medal in Class IV., in which I exhibited my process. I complain also of the injustice done me by not having jurors competent, from their knowledge of manufacturing processes, to judge of the value of my inventions, and of their not having called before them any person competent to give an opinion on the subject; also of the injustice done me, inasmuch as, notwithstanding my repeated application to show and to explain to the jury the whole of my processes, they refused and neglected to examine the same. And further, I complain of the existence, on the part of some of the jurors, of an ill or partial feeling with respect to me and my process, and of which I was informed by one of the jurors in a letter, of which the following is a copy:—

"*London, October* 6*th,* 1851.

"Sir,—I am ignorant why our communications have been interrupted. I do not wish to tell you all that I have said in your favour in Class IV. *You are the victim of combinations which a foreigner like myself cannot destroy.*

"I intend to give a long notice of your process in my report to the Spanish Government. The little samples which you gave me at the Exhibition will be worthily placed by it in the Museum of Industry at Madrid. I should like to have the series completed of bleached and coloured fibres, and of the fabrics made from them, which you promised me. There is yet time, for I am occupied in putting my extensive collection in order.

"I renew to you the expression of my high consideration.
"The Chevalier Claussen."

"Ramon de la Sagra."

I would further take the liberty of stating, with the view of showing the value of my invention in a national point of view, that it has been the means of causing upwards of 30,000 additional acres of flax to be cultivated in this country in the present year; that about 2,000 acres have been already purchased by me, and agreements entered into for the purchase of a still larger quantity; and that I have every reason to believe that, by the end of the present year, the whole of such additional crops will have been purchased either by myself, or by others holding licenses under me, for the purpose of its conversion, under my process, into fibre for the linen manufacture, or into a substitute or auxiliary for cotton and wool, and at a cost in each case of considerably less than that at which the raw material of flax, cotton, or wool, can be now obtained, or imported into this country. The advantages of my invention may be stated to be—to open to the agriculturists of this country, new, extended, and profitable home markets for their produce—to render our manufacturers less dependent upon the precarious and uncertain supplies of the raw material from foreign countries—to reduce the cost of linen fabrics to less than one half of their present price, and also to cause a large reduction in the price of woollen goods, and thus increase consumption, afford additional industrial employment, and promote the comforts of all classes of the community.

I would also call the attention of your royal highness and of your lordships to the fact, that at the State Fair, held at Rochester, United States, a silver medal and diploma were given on the 20th ultimo, to an exhibitor of some small specimens similar to those shown by me at the Great Exhibition. I would also further beg to state, that I have made no single statement in the above, which I was not, and am not able, fully and completely to verify and substantiate; and, entertaining these opinions, I beg again most respectfully to decline to accept the medal awarded to me by the jury in Class IV.

Congratulating your Royal Highness and the Royal Commissioners on the marked and deserved success which, previous to the awards of the jurors, has attended this great national undertaking, I have the honour to remain,

Your Royal Highness's and your Lordships'

Most obedient servant,

P. CLAUSSEN.

# APPENDIX C.

Immediately after Mr. Bazley's lecture at the Society of Arts, a letter was written to that gentleman, calling his attention to the incorrectness of the statements made by him in reference to flax-cotton. To prove such incorrectness, samples of yarns *composed entirely of flax, and spun on cotton machinery, together with cloth made therefrom*, were forwarded to him. To this communication, Mr. Bazley promptly replied, in the following letter :—

"*Manchester, April 7th*, 1852.

"Sir.—This morning I have received your letter of the 5th instant. Being personally acquainted with attempts to spin *flax* upon cotton machinery, I can assure you that I have rather *under* than *over* stated what the facts in my possession would justify me in expressing.

"Many cotton-spinners have been much disappointed (acting under promises and directions), that their attempts to spin *flax* upon their cotton machinery proved abortive.

"Many farmers and landowners have inquired in this city, whether *flax* was being worked, or spun here upon cotton machinery, and the result of their inquiries has been unsatisfactory to them. *The specimens which you have sent are neither strictly flax nor cotton products.* I have no hostile feeling towards any one; but the truth I cannot withhold.

"Sir, your obedient Servant,

"THOMAS BAZLEY."

Mr. Bazley is quite right; the attempts to spin *flax* on cotton machinery have proved abortive: but why does he make no allusion to *flax-cotton?* Why not state that *Claussenised flax* had been tried on cotton machinery, and had proved inapt?

The question was not whether *flax, in its normal condition*, could be spun like cotton; but whether *flax cottonised by Claussen's process*, could be so treated.

Some time ago, the author of a peculiar method of treating *flax*, forwarded a quantity to Mr. Bazley, requesting him to spin it on cotton machinery. This flax, however, had not been subjected to Claussen's process, nor had it been even divided into lengths suitable for cotton machinery. Of course, Mr. Bazley could not spin it; and hence the origin of some portion of that gentleman's "*personal experience.*"

The very foundation of Claussen's experiments, and of his success, was the perfect conviction that, to lay flax open to the same course of manufacture as cotton, it was necessary to alter its physical character most materially; and, for this purpose, he subjected it to such a course of treatment, that even Mr. Bazley is obliged to confess, that "*the specimens which you have sent, are neither strictly flax, nor cotton products.*"

This confession leads us, of course, to infer that such products, or materials resembling them, were not represented by the *flax*, "with attempts to spin which, upon cotton machinery, Mr. Bazley tells us he was personally acquainted."

Mr. Bazley is a man of great experience in textile matters; and, on his own showing, Claussen has, from *flax*, produced a *novel material, which is "neither strictly flax nor cotton,"* but which, "the specimens sent" *proved beyond a cavil, could be spun on cotton machinery.*

Mr. Bazley's mistake—for his high character places him above the suspicion of wilful misrepresentation—has, doubtless, arisen from the fact of his having confounded the process of Mr. Donlan, or some one else, with that of Claussen.

For reasons, to which slight reference has elsewhere been made, Claussenised cotton, up to this time, is but little known in Manchester; the matter is too gigantic for individual enterprize, and therefore the aim of the patentee has hitherto been confined to the establishment of the truth and economy of his invention, leaving to others the more extended production of the article.

## APPENDIX D.

The celebrity attained by Claussen, as the discoverer of a successful method of adapting flax to cotton, woollen, and silk machinery, has given birth to a host of imitations. Every now and then a paragraph appears in some of the local papers, stating that a gentleman has "called at this office, and left a very superior sample of flax fibre, very closely resembling cotton, and which is said to be prepared by a new process, totally different from that of the Chevalier Claussen's; a patent is about being taken out," etc., etc.

It seems to be the lot of all who become the authors of remarkable inventions, that they should be doomed to run the gauntlet among a host of men, whose genius is limited to the capacity of discovering some loop-hole in the details of a specification; and who, having caught an idea, endeavour, in its realisation, merely to escape the clutches of the law by some unimportant variation in the process.

Unfortunately, also, the law affords but little security to the originator of an idea, or to the first successful author of a process. The following is a familiar illustration of the condition of an inventor:—

A invents and manufactures a new and most useful apparatus, hitherto unknown, which we agree to call a "*tea-kettle.*" The public are delighted and grateful for such a convenient mode of heating water; and the invention is duly described, and patented. In the course of time B calls at some newspaper office, and leaves an apparatus differing from that of A, "for which a patent is about to be taken out," etc.

In what does the difference exist? In this, merely:—Whereas, in the tea-kettle of the original inventor A, the spout is in a line with the *long axis*; in the tea-kettle of B, the spout is in a line with the *short axis*: and for this unmeaning difference—not even an improvement—he claims to be an inventor.

Having once discovered a *principle,* or *idea,* the methods of *realising* may be so many, and so varied, that scarcely any specification can contain them; but it is unfair that the original discoverer should be exposed, as he is now, too frequently, to the piracies of *quasi* inventors.

To protect himself as much as possible, the Chevalier endeavoured to make his specification as wide, and as complete, as might be: and to avoid *even colourable evasions,* he has enumerated methods of obtaining flax-cotton, the adoption of which he would not recommend; and an allusion to which, were his object not remembered, would appear ridiculous.

For the guidance of would-be inventors, and of those who may be called upon to assist them, the following extract from Claussen's specification is given: –

"I use any mechanical, chemical, or electrical means, which are best adapted for cutting, tearing, dividing, or separating the fibres into lengths suitable for spinning on cotton, woollen, or silk machinery, either alone, or in combination.

"Among the mechanical means which may be employed, are *cutting, tearing,* or *beating,* either in the straw, or fibre, by suitable machinery, or by hand, and either with, or without, previous preparation.

"Among the chemical means, I may mention:—The long-continued action of alkalis, and alkaline earths, and of salts, like borax, having an alkaline re-action; and of acetates, at whatever temperature employed:

"The long-continued action of boiling water, or of steam, or of both, and applied either with, or without previous preparation by chemical means:

"The use of certain solvents — such as acids, which, being brought in contact with portions of the fibre, will cause it to separate into given lengths:

"The action of heated metals upon portions of the fibre, by which it is divided:

"Long, or over-bleaching by any of the ordinary or known methods:

"Long, or repeated fermentations, whether in water of the ordinary temperature of the air, as under the old system of water-retting, or under a high temperature, produced by artificial means; and whether in water alone, or aided by certain fermenting agents, such as sugar, yeast, etc.:

"By exposure to the air, or dew-retting;

"By natural fermentation in heaps;

"By first fermenting, and then treating with alkalis, acids, alkaline earths, salts with an alkaline reaction, acetates; the chemical action of steam, or hot water, or of both, and of bleaching agents; or *vice versâ*:

"By sudden, or gradual changes of temperature:

"By first freezing, and then steaming, or *vice versâ*:

"By the action of the sea-water, either in its natural state, or after the removal of some of its salts:

"By the action of any of the known agents which are capable of dissolving, removing, precipitating, or softening the glutinous, gummy, and extractive matters which bind the fibres together, and prevent their spinning on cotton, woollen, or silk machinery, either alone, or in combination with other materials:

"In some cases, it may be found convenient to inject any of the above agents into the fibre, either by atmospheric pressure, produced by a *vacuum*, or by mechanical forces.

"I am aware that some of the means above referred to are injurious to the fibre, and others are inconvenient, and expensive; yet I have thought it right to mention them. The distinguishing feature, however, of my invention is, the conversion (by whatever means) of flax, or other like material, into a substance which can be spun on cotton, woollen, or silk machinery.

"I, however, prefer the use of carbonates and acids, such as the carbonate of soda, and the sulphuric acid, as above specified.

"The cottonising process may also be carried on, either in the straw, or fibre, and either in its natural or divided state."

1852.

# Catalogue of Useful Books

PUBLISHED BY

## EFFINGHAM WILSON, 11, ROYAL EXCHANGE,

LONDON.

---

In addition to the Works enumerated in this Catalogue, THE BOOKS OF ALL OTHER PUBLISHERS may be had at this Establishment immediately on their Publication.

---

## The Life and Times of Sir Thomas Gresham,

FOUNDER OF THE ROYAL EXCHANGE;

Including Notices of many of his contemporaries, by JOHN WILLIAM BURGON, ESQ. Now offered, *for a limited time*, at the very *reduced price of* 15*s.* In two handsome large octavo volumes, embellished with a fine portrait, and twenty-nine other engravings, *elegantly bound in cloth. Recently published at* £1 10*s.*

SIR THOMAS GRESHAM lived in the reigns of Henry VIII., Edward VI., Mary, and Elizabeth—Reigns not exceeded in interest by any period of our history; and never was a man's life more actively and usefully spent in benefiting the land of his birth, and enriching its metropolis. Commerce, in particular, then made a gigantic stride, of which he was by no means an inactive spectator; and he has been not inaptly styled the "Great Patriarch of Commerce and Commercial Finance."

With a liberality truly patriotic, he erected for the convenience of Merchants, the ROYAL EXCHANGE; and in addition to his other extensive charities, founded and endowed Seven Lectureships, for the gratuitous instruction of the CITIZENS OF LONDON in the seven liberal sciences.

It is therefore confidently presumed, that few Merchants, Bankers, or Members of the Corporation of the City of London, will be without it.

*Very few* copies remain for sale of the large paper in 2 vols. royal 8vo. with proof impressions of the plates, price £1 5*s.*, published at £3.

These are two magnificent volumes in regard to size, illustration and typography; nor are their literary contents unworthy of their external splendour, or the fame of the distinguished merchant to whose biography they are devoted.—UNITED SERVICE GAZETTE.

---

☞ NOTICE.—*Any Volume not exceeding* 1*lb. in weight, may be sent, post-free, to any part of the United Kingdom, for Sixpence in addition to the price.*

## Money and its Vicissitudes in Value;

As they effect National Industry and pecuniary contracts; with a postscript on Joint Stock Banks. By SAMUEL BAILEY, Esq., Author of "Essays on the Formation of Public opinion," &c.

224 pp. 8vo. Price 6*s.* boards.

## Tuck's Railway Shareholders' Manual;

Or Practical Guide to all the Railways in the World completed and in progress; containing Abstracts of the Railway Acts; Advice to Shareholders; the Laws relating to Shareholders and Speculators; Brokers' Rates of Commission for buying and selling Shares; Table to estimate Railway Dividends; Gross Earnings of all the principal Railways; Table showing the Price of Shares; Railways open; Railways in course of Construction; Railways which received the Royal Assent last Session; Foreign Railways; Railway Offices and Officers, alphabetically arranged. The Accounts and Traffic corrected to the present time; forming the most complete Railway Synopsis ever compiled. By HENRY TUCK.

Tenth Edition, greatly enlarged. Price *s.* bound in cloth,

## The Railway Returns, 1849, 1851,

Made to the Special Orders of the House of Lords; prefaced with the results of previous returns, with a view to a complete comprehension of the nature of Railway Investments, and the restoration of confidence, by the adoption of a sound policy of management. By ARTHUR SMITH, Author of "Railways as they really are," etc.

Price 2*s.* 6*d.*

## Mining, on the Cost Book System.

A Treatise on British Mining; with a Digest of the Cost Book System, Stannarie, and General Mining Laws. By THOMAS BARTLETT.

In 8vo., cloth, Price 4*s.*

## Fynn's British Consul's Handbook.

British Consuls abroad; their Origin, Rank, and Privileges, Duties, Jurisdiction, and Emoluments; including the Laws, Orders in Council, and Instructions by which they are governed, as well as those relating to Shipowners and Merchants in their connexion with Consuls. By ROBERT FYNN, Esq., Barrister-at-Law.

This work is written with manifest care and judgment; its contents are not only of vital importance to Consuls, but to Merchants, Shipowners, Captains, and Travellers.—MORNING CHRONICLE.

New Edition, with the new ACT OF PARLIAMENT for facilitating MARRIAGES ABROAD. Price 6*s.*, neatly bound, dedicated (by permission) to the General Shipowners' Society.

## Natal, Cape of Good Hope,

A Grazing, Agricultural, and Cotton-growing Country; comprising Descriptions of this well-endowed Colony, from the year 1575 to the present time, by Government Officials and Travellers; with a Vocabulary of the Zulu Language, a Map of the Colony, and Engravings. By J. S. CHRISTOPHER, of Natal.

4*s.* bound, with Views and Coloured Map.

## The National Debt & Public Funds Simplified.

BY JUSTIN BRENAN,

Author of "Composition and Punctuation familiarly explained."

This is the cleverest exposition of these otherwise complicated matters ever published.—THE CRITIC.

Second Edition, with additions, 1*s.* cloth, or Post free on receipt of 16 Queen's Heads.

# Schönberg's Chain Rule.

A Manual of brief Commercial Arithmetic, being an easy, simple, and efficient auxiliary in the working of difficult and complicated Problems; applied to Proportion, simple and compound, direct and Inverse; Discount; Barter; Interest, simple or compound; Profit and Loss; Fractional Numbers; Exchange; Tare, &c. For the use of Schools, Counting-houses, and Self-Tuition.

By CHARLES LOUIS SCHÖNBERG.

The Chain-Rule is a simple, easy, and clever system of arithmetical computation, only requiring to be known to be generally adopted, to the total exclusion of Ready Reckoners and the Rule of Thumb. There is a fascination in the very arrangement of the figures; in fact, it is an amusing as well as a most useful study nd we strongly recommend the Chain-Rule as arranged and applied by Mr. Schönberg.—LIT. GAZ.

Fourth Edition Neatly bound in cloth, price 1*s.* 6*d.*

# The Story without an End.

The Story without an End. From the German of F. G. CAROVÉ, by Mrs. AUSTIN.

This is a delightful fairy tale; we are all indebted to Mrs. Austin for one literary work or another, but our children's children will thank her for this. The book altogether is a literary gem.—ATHENÆUM.

Appropriately embellished with 18 Wood Engravings, in the first style of the art, from the pencil of Harvey, price 2*s.* 6*d.*, neatly bound in cloth; or in watered silk, gilt edges, 4*s.*

# The Author's Guide.

A Guide to Authors; showing how to correct the press, according to the mode adopted and understood by Printers. Price 6*d.*

# New English Grammar.

An Elementary English Grammar, upon an entirely new principle, especially adapted by its simplicity and its numerous exercises, for the junior classes in schools, for private tution, or for self-instruction.

By W. H. PINNOCK, B. C. L.

New Edition. Price 1*s.* bound in cloth.

Pinnock's Grammar as issued into the world by Effingham Wilson, is the best and clearest that has ever appeared, and ought at once to supersede every other book of its class.—UNITED SERVICE MAGAZINE.

# History in Rhymes.

Rhymes for Youthful Historians: designed to assist the Memory in retaining the most important Events in the History of England, etc.

How many are there of the common affairs of human life, which have been taught in early years by the help of rhyme, and have been like nails fastened in a sure place. * * * It is from this principle that moral rules have been cast into a poetic mould from all antiquity.—DR. WATT'S IMPROVEMENT OF THE MIND.

You must not laugh at this, for chronologists do not pique themselves on their poetry; they make use of numbers and rhymes merely as assistants to memory, being so easily learned.—MRS. CHAPONE.

Sixth Edition, brought down to the Reign of Queen Victoria, with 37 Portraits of Sovereigns, price 1*s.* sewed, or neatly bound in cloth 1*s.* 6*d.*

# Miss Iselin's Poems.

My Dream Book: Poems. By SOPHIA ISELIN. Price 3*s.* 6*d.* in cloth, or 5*s.* in silk, with gilt edges.

# Instinct and Reason definitively Separated,

And consequently inclnding an Answer to "The Vexata Quæstio of Brute Reasoning," which has so long perplexed the ablest writers on that important point. By GORDONIUS.

An able little treatise on the distinction between the reason of man and the instinct of the lower animals.—MORNING POST.

In 18mo., price 1*s.* 6*d.*, in cloth.